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MODDER Q&A: HEATH COOP



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MAD READER MOD

JEFFREY STEPHENSON'S
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Mad Reader Mod: SkyVue, By Jeffrey Stephenson



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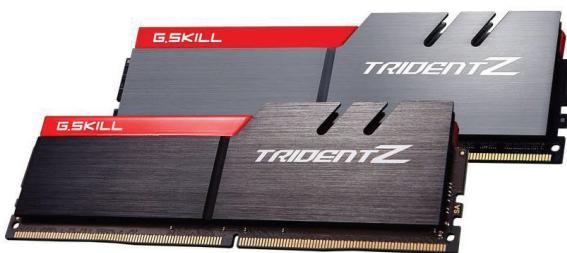
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G.SKILL Cranks Up To 4,333MHz & More With New Trident DDR4 Kits

Memory manufacturer G.SKILL has announced a new ultra-fast Trident Z memory kit. The company said its new Trident Z DDR4-4333MHz 16GB is the first desktop memory available in the market at that speed that uses two 8GB modules. The 1.4V memory has latency timings of CL19-19-19-39. In addition to this new speedy kit, G.SKILL says it has other kits in the same family under development that are even faster. As proof, the company released a stress test screenshot showing a 16GB DDR4 kit with memory timings of CL19-19-19-39 reaching speeds of 4,402MHz, and another screenshot of a 16GB kit with the same timings breaking 4,500MHz. The company says the DDR4-4500MHz kit was a “proof of concept.” The DDR4-4400MHz memory kit is actively being developed, but G.SKILL says it will “require some time to be ready for market production.”

EVGA Upgrades Its Bronze PSU Lineup With Smaller B3 Models

EVGA has released a new series of power supplies that are rated at 80-PLUS Bronze efficiency. The new B3 Series is more compact in size than the preceding B2, plus it incorporates some nice new features. The B3 Series is available in 450W, 550W, 650W, 750W, and 850W capacities. The units measure just 150mm long for the 450/550/650, and 160mm for the 750/850. EVGA says its latest bronze series now has modular cables and comes with the company’s ECO Intelligent Thermal Control System, which keeps the fan turned off until the PSU hits a certain load level. EVGA says the hydraulic dynamic bearing fan in the B3 also runs quieter and has a longer life span. The new power supplies target price-conscious users who still want a quality product. MSRP for the B3 PSUs are as follows: 450/\$49.99; 550/\$59.99; 650/\$69.99; 750/\$89.99; and 850/\$99.99.



WATCHING THE CHIPS FALL

Here is the pricing information for various AMD and Intel CPUs.

CPU	Released	Original Price	Last Month's Price	Online Retail Price*
AMD Ryzen 7 1800X	3/2/2017	\$499	\$499.99	\$469.99
AMD Ryzen 7 1700X	3/2/2017	\$399	\$399.99	\$395.99
AMD Ryzen 7 1700	3/2/2017	\$329	\$299.99	\$329.99
AMD FX-9590 Eight-Core (Vishera)	6/11/2013	n/a	\$178.00	\$159.99
AMD FX-8370 (Vishera)	9/2/2014	\$199.99	\$149.99	\$139.99
AMD A10-7890K (Godavari)	3/1/2016	\$164.99	\$148.99	\$149.99
AMD A10-7870K (Godavari)	5/28/2015	\$137	\$119.99	\$94.99
AMD A10-7860K (Godavari)	2/2/2016	\$116.99	\$94.99	\$100.94
AMD Athlon X4 880K (Godavari)	3/1/2016	\$94.99	\$79.99	\$79.99
AMD Athlon X4 845 (Carrizo)	2/2/2016	\$69.99	\$56.60	\$60.73
Intel Core i7- 6950X (Broadwell E)	5/31/2016	\$1,723**	\$1,649.99	\$1,649.99
Intel Core i7- 5960X Eight-Core (Haswell)	8/29/2014	\$999**	\$1,069.65	\$1,069.65
Intel Core i7- 6900K (Broadwell E)	5/31/2016	\$1,089**	\$1,049.99	\$1,049.99
Intel Core i7- 6850K (Broadwell E)	5/31/2016	\$617**	\$574.99	\$609.99
Intel Core i7- 5930K Six-Core (Haswell)	8/29/2014	\$583**	\$620.80	\$613.17
Intel Core i7- 5820K Six-Core (Haswell)	8/29/2014	\$389**	\$389.99	\$409.99
Intel Core i7- 6700K Quad-Core (Skylake)	8/5/2015	\$359**	\$339.99	\$339.99
Intel Core i7-4790K Quad-Core (D.Canyon)	6/25/2014	\$339**	\$406.99	\$407.99
Intel Core i7-4790 Quad-Core (Haswell)	5/11/2014	\$303**	\$372.16	\$363.60
Intel Core i5-6600K Quad-Core (Skylake)	8/5/2015	\$249**	\$239.99	\$239.99

* As of April 2017

** Manufacturer's estimated price per 1,000



Biostar Intros Mini-ITX For Ryzen

BIOSTAR is adding two more models to its RACING Series of motherboards. The company says the new RACING X370GTN and RACING B350GTN are not only the world's first Mini-ITX motherboards developed for AMD's Ryzen platform, they're also the first boards sporting the X370 and B350 chipsets that are RGB. The RACING X370GTN and RACING B350GTN are both equipped with the BOSTAR 5050 LED Fun Zone package that includes two 5050 LED headers and VIVID LED DJ software to control your system's lighting. The two motherboards support other BOSTAR features as well, such as the company's FLY.NET networking utility that allocates more bandwidth to online gaming. The boards have two DIMMs and can handle up to 32GB of DDR4-3200 (OC). They support USB 3.1 Gen 2 Type-C (one port each) and have one M.2 and four SATA3 6Gbps connectors. MSRP for the RACING X370GTN is \$129, while the price of the RACING B350GTN is \$109.

Thermaltake's View 28 RGB Is An ATX Chassis With Gullwing Panel

Thermaltake has a new ATX midtower chassis series called View 28 that includes a windowed side panel that wraps around the top of the case. The company says the gullwing panel design permits you to admire every component in your build from the side as well as the top. (There's a tinted front panel as well.) There are two versions of the chassis: a base edition that comes with a 120mm exhaust fan, and a Riing Edition version that comes with one of Thermaltake's Riing RGB fans. The chassis of the View 28 RGB comes with an RGB LED controller integrated into the upper front panel. The RGB Matrix controller button lets you control all the lighting in your system. The tool-free chassis comes with a PSU shroud, and there's room for a dual-slot GPU up to 410mm and multiple drives. Fans of liquid coolers can place a 360mm radiator in the front.



NVIDIA Springs New Top-Of-The-Line Pascal Graphics Card, The Titan Xp



Just weeks after launching the powerful GeForce 1080 Ti, NVIDIA unveiled a new top-of-the-line graphics card called the Titan Xp. The latest card to carry the Titan title has 3,840 CUDA cores and a boost clock speed of 1,582MHz. It has 12GB of GDDR5X, a memory speed of 11.4Gbps, and a total memory bandwidth of 547.7Gbps. NVIDIA says the Titan Xp with Pascal architecture is capable of processing up to 12Tflops and offers up to three times the graphics performance of the previous Titan version, the Titan X with Maxwell architecture. The new two-slot Titan Xp card draws 250W of power and has one 8-pin and one 6-pin power connector. The card keeps temperatures under control by using vapor-chamber cooling. The MSRP for the Titan Xp is \$1,200. Enthusiasts with extra-deep pockets will be thrilled to hear the card supports SLI (NVIDIA has 2-, 3-, and 4-way bridges available for \$39).



FSP Launches New Dagger Series PSUs For Small-Form-Factor Systems

FSP Group announced a new line of SFX power supplies. The Dagger series is launching with two models: the 500W and 600W.

The new PSUs have a single 12V rail and are rated 80-PLUS Gold for efficiency. They are fully modular and are equipped with flat ribbon cables. FSP says the Dagger series uses high-quality Japanese capacitors, and each unit is cooled with a dual ball-bearing fan. The company says the SFX Dagger has twice the power density as a typical ATX power supply.

The Dagger 500W has an MSRP of \$99, while the Dagger 600W is priced at \$109. Both models have a five-year warranty.

HARDWARE MOLE



MSI Announces New GAMING X+ GeForce Graphics Card Series

MSI continues to segment its graphics card offerings and has announced a new GAMING X+ series that uses GeForce GTX 10 Series GPUs. The GAMING X+ appears to fall between the GAMING X and GAMING Z series in terms of power and performance. So far, MSI has announced two GAMING X+ cards based on the GTX 1080: the GTX 1080 GAMING X+ 8G and the GTX 1080 GAMING X+ 6G. Aside from differing amounts of GDDR5 memory as indicated in the names, the cards also differ in clock speeds. The GTX 1080 GAMING X+ 6G uses a GP106-400 GPU and has base/boost clocks of 1,594/1,809MHz, while the GTX 1080 GAMING X+ 8G uses a GP104-400 GPU and has base/boost clocks of 1,771/1,911MHz.

Republic Of Gamers Launches ROG Gladius II Gaming Mouse

ROG has a new Gladius mouse. The ROG Gladius II updates the original with a more sensitive optical sensor, topping out at 12,000dpi as opposed to 6,400dpi. The Omron switches have been upgraded as well and are now rated at 50 million clicks instead of 20 million. You can still swap out switches to match your taste and gaming style, only now there are rubber covers instead of sticky adhesive pads on the screws you remove to change out parts. Along with the original DPI switch that lets FPS gamers adjust sensitivity when aiming, ASUS says there's now a DPI target button near the thumb, so you can make adjustments with less interference to gameplay. The new Gladius II is RGB and supports ASUS Aura Sync.



"Lip Passwords" Could Offer New Authentication Alternative

Researchers at Hong Kong Baptist University believe a lip-motion password technique they're developing could change the way we access secure systems and areas. As the name implies, a lip-motion password uses a person's lip motions to create a password, extracting the visual features of lip shape, texture, and movement to characterize a person's lip sequence, which a system matches with the password content for authentication.



Department of Computer Science Professor Cheung Yiu-ming said the lip password has a number of advantages over conventional access-control methods. Lip passwords can't be mimicked, so a system can validate a user while also rejecting both the correct password spoken by an imposter and the incorrect password spoken by the user. Compared to current voice-based authentication, Yiu-ming said, a lip password is less susceptible to background noise and distance, plus a speech-impaired person could use the technology. In addition, speakers of any language can use lip passwords, and users can reset lip passwords as needed. The technology can work by itself or in conjunction with other biometrics such as facial recognition.

SOFTWARE SHORTS

iPhone Users Spending More On Apps & In-App Purchases

Owners of iPhones in the United States spent about 14% more on apps and in-app purchases last year, according to a study by Sensor Tower Store Intelligence. The average user spent \$40 in 2016, with more than 80%, or \$27, of that spent on games.

The biggest gains were in the entertainment category, which includes apps such as HBO NOW, Hulu, and Netflix, Sensor Tower reports. Although dollar-wise the number is small (iPhone users spent about \$2.30 on entertainment apps last year), spending was up 130% from the \$1 the average user spent on entertainment apps in 2015. In the entertainment category, Netflix saw its App Store subscriptions increase from about



Android Reaches "Milestone In Technology History"

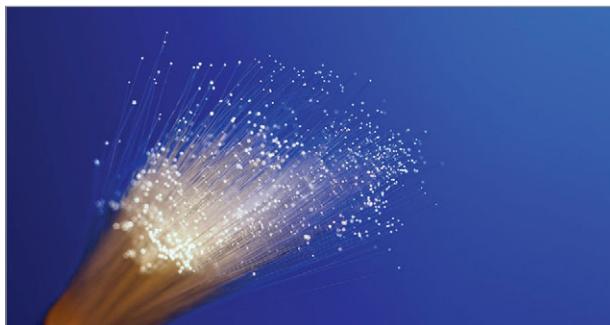
Android has officially taken the reign as the world's most popular operating system for internet use away from Microsoft—though just barely, according to the most recent numbers from web analytics provider StatCounter. At 37.93%, Android's share of the worldwide OS internet usage market is just ahead of Microsoft's 37.91%. "This is a milestone in technology history and the end of an era," said StatCounter CEO Aodhan Cullen. "It marks the end of Microsoft's leadership worldwide of the OS market, which it has held since the 1980s." The growth in the smartphone market, combined with declining sales of traditional PCs, drove the shift.

Microsoft has little to fear in the worldwide operating system desktop market, though, according to StatCounter. The group's most recent North America numbers show Microsoft with a 39.5% share, followed by iOS with 25.7% and Android with 21.2%.



\$7.9 million gross revenue in the fourth quarter of 2015 to more than \$58 million in the fourth quarter of 2016, according to Sensor Tower. Other app categories also saw increased spending year-over-year: photo and video spending was up from \$0.30 in 2015 to \$0.70 in 2016, while spending on music was up from \$3.40 to \$3.60.

Although spending on apps increased, the actual number of app downloads and installs declined slightly. In the fourth quarter of 2016, the average iPhone user downloaded 33 apps, down from an average of 36 a year earlier. Social networking apps saw the biggest decline, going from an average of 3.3 apps to 2.3 apps over the past year. Game app downloads were also down slightly, from 10.5 in 2015 to 9.9 in 2016.

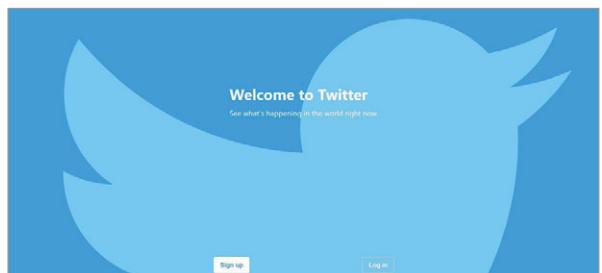


Nokia, Facebook Break Spectral Efficiency Records

A technology being developed by Nokia Bell Labs could increase the capacity of subsea links by about 2.5 times, according to recent tests conducted by Nokia and Facebook. Probabilistic constellation shaping, or PCS, technology uses “shaped” QAM (quadrature amplitude modulation) formats that can flexibly adjust transmission capacity to near the physical limits of each fiber-optic link. Nokia and Facebook tested PCS on a 5,500km submarine cable between New York and Ireland. The test achieved a record spectral efficiency of 7.46b/s/Hz, which Nokia notes shows the potential to upgrade that cable to 32Tbps per fiber. Dr. Stephen Grubb, Facebook’s global optical network architect, said the demonstration shows PCS can achieve capacities close to what’s called the Shannon limit, or the maximum transfer rate of a communications channel. Such advancements ensure companies are maximizing their investments in submarine cable systems and lowering the cost per bit of submarine transport, he said.

Twitter Rolls Out Version Designed To Minimize Data Use

Twitter knows there are barriers to using its program: slow mobile networks, expensive data plans, and lack of storage on mobile devices, to name a few. Its newest mobile version—available via smartphone or tablet at mobile.twitter.com—loads more quickly over slow connections, takes up less space on mobile devices, and is more resilient to unreliable mobile networks, the company notes. Twitter Lite still has the key features of Twitter, including the timeline, Tweets, Direct Messages, trends, profiles, media uploads, and notifications, but with 30% faster launch times and quicker navigation, according to Twitter. A new data-saver mode lets you preview images and videos before fully loading them, saving mobile data. Offline support ensures you’ll be able to use the site if you temporarily lose your connection. Twitter Lite is available to users around the world, but the company notes it will be especially helpful to users in emerging markets throughout the Asia-Pacific region, Latin America, and Africa, allowing many users to experience Twitter for the first time.



SITE SEEING

Kaspersky Lab Looks Into The Future With Earth 2050 Project

To celebrate 20 years in the cybersecurity business, Kaspersky Lab called upon its researchers, artists, scientists, futurologists, and everyday users to create an interactive multimedia project called Earth 2050 (2050.earth). The project provides visual- and text-based predictions and views (including 360-degree ones) of social and technological developments for various global cities in 2030, 2040, and 2050. Kaspersky says it’s aiming to understand how Earth will look in the relatively near future so it can better understand the challenges introduced in the future.



Earth 2050 currently has predictions for 80 global cities users can access by choosing a city and then clicking prompts. Predictions are available in three categories covering 2030, 2040, and 2050. In addition to written predictions, Earth 2050 includes a dozen VR-enabled panoramas of cities and illustrations of artifacts that experts predict will exist in the future.

While anyone can view the predictions, those who register can offer their own ideas by submitting ordinary and 360-degree objects (a city, for example). Kaspersky’s editorial team will review the submissions and publish those it approves. Kaspersky states that it plans to frequently add new content.

GENERAL DYNAMICS

Job Of The Month

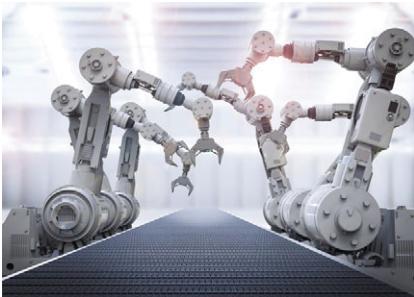
Every business seeks to develop technology that will give it an edge over the competition, but nowhere is that need more critical than for companies in the defense industry. General Dynamics is a leading player in national defense, and the company is always looking for top-notch technical talent. If you're a new engineering or computer sciences graduate, you might want to check out entry-level opportunities at GD. The company currently has an embedded software engineer position at its Dedham, Massachusetts, offices that is designated for new grads. Candidates must have a B.S. in engineering or equivalent and experience with Agile is preferred. You'll need to be able to pass a background check, too, as the person in this position must be able to obtain a secret security clearance. Job details are somewhat vague, as you might expect, but GD says you'll be part of a team that analyzes requirements and then designs, builds, and tests software apps and systems for new company products.

Source: www.generaldynamics.com

Robot-a-job-aplyse

Pundits have been warning us for some time that robots are coming to take all our jobs, but that may not happen as soon as they think. Forrester now predicts that robots, job automation, and artificial intelligence will claim about 24.7 million jobs in the next 10 years, but (and this is the good part) the new technologies will create 14.9 million new jobs, too. So although there's still a net loss of some 9.8 million jobs in the United States by 2027 due to the ongoing robot invasion, it might not be as catastrophic as some folks would have you believe.

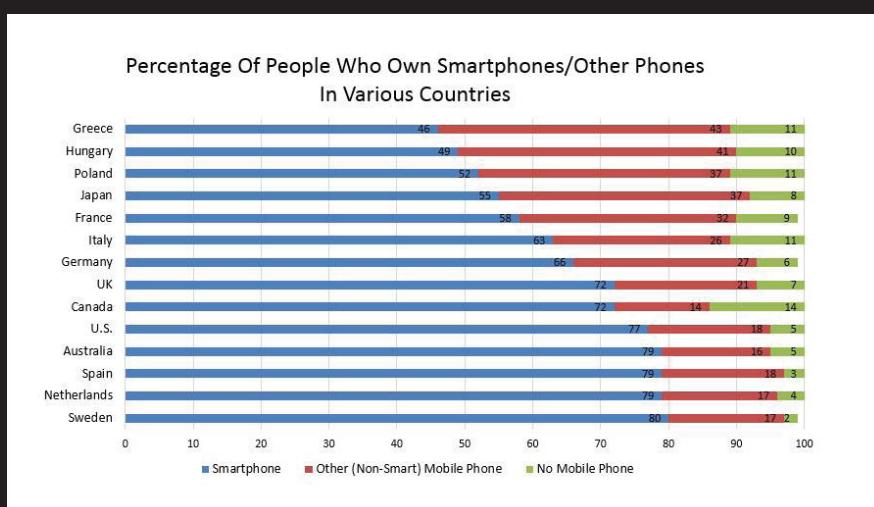
Source: Forrester Research Inc.



The World At Your Smartphone-Owning Fingertips

In an age where you can buy phone apps that let you chase imaginary creatures or keep track of the beers you drink, it's easy to forget that not everyone has an internet-connected phone. The prevalence of smartphones and mobile phones in general varies around the world, as shown in the table below.

Source: Pew Research Center (NOTE: Due to rounding, totals for some countries do not equal 100%)



RAW Numbers:

92

The percentage of car owners in the United States who occasionally perform activities while driving that require a mobile or internet connection.

Parks Associates

117

The year-over-year percentage increase in total dollar sales of drones in the United States (with year-end being February). Drones priced at \$1,000 or more sold at a faster clip than all other price points during the first two months of this year, with drones costing more than \$300 accounting for 84% of sales.

NPD Group

145

The number of minutes per day that the average adult in the United States is forecast to spend using mobile apps during 2017. This is an increase of more than 10% over the time they spent on apps in 2016. People are spending more time on fewer apps, as the number of apps they use regularly is actually decreasing.

eMarketer

\$352.4 billion

The total revenues of the global semiconductor market in 2016. This was about 2% higher than the total from 2015.

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And Now, For Your Moment Of (Ry)Zen

AM4 Motherboard Roundup

AMD is not throwing away its shot. In the spirit of the “Hamilton” refrain, Team Red has proved to be scrappy and hungry to get back into the enthusiast market with its Ryzen processors. Smashing every expectation, AMD is ready to rise up and contend with Intel’s monarchy.

As with most major CPU architecture changes, moving to Ryzen means you’ll need a new motherboard. Ryzen’s AM4 platform introduces several new chipsets, including X370, B350, A320, X300, and A300. Thus far, motherboard makers have gravitated toward the X370 and B370 chipsets, as these two platforms both support overclocking and have better onboard connectivity, such as native USB 3.1 ports and more general-purpose lanes, than the A320, X300, or A300 chipsets. Our roundup includes three X370 motherboards and one B350 board, so you can get a general idea of the differences.

The X370 chipset is the option mostly likely to attract enthusiasts, because it supports both SLI and CrossFire configurations. Similar to Intel’s recent mainstream processors, Ryzen CPUs provide 16 PCIe 3.0 lanes for graphics use. When two GPUs are installed, the X370 chipset splits this bandwidth into x8/x8. Some X370 motherboards also support 3-way CrossFire, though the third PCIe x16 slot is typically wired for only PCIe 2.0 x4 bandwidth. The B350 chipset doesn’t support SLI at all, and though CrossFire is possible on some B350 motherboards, GPU lane bandwidth is split at PCIe 3.0 x16/PCIe 2.0 x4.

Ryzen processors have an integrated dual-channel DDR4 memory controller. With AMD’s X370 and B350 chipsets, motherboard manufacturers can support overclocked memory (Ryzen processors support up to DDR4-2667), but as we began work on this roundup, memory support was still a work in progress. As an example, we tested the boards in our roundup with a 16GB HyperX Predator DDR4-3200 kit, and although all the motherboards were able to boot using the 3,200MHz XMP settings, benchmark numbers were sometimes better with the kit running at 2,933MHz.

When we brought this up, motherboard companies told us that it’s important to always use memory that’s been qualified and tested for the specific board—not currently as easy task for a roundup. To fairly compare the motherboards, we tested all the boards using the HyperX Predator’s 2,933MHz profile. In general, qualified high-speed kits vary widely from board to board, though most support up to DDR4-3200 in some capacity. Just as we were going to press (and once all of our benchmark testing was complete), AMD told us it had recently released new microcode that will improve memory capability; some vendors had updated their BIOS downloads accordingly, while others had not. Go to your motherboard manufacturer’s website and look for a BIOS with AGESA 1.0.0.4a firmware. You might have to apply a BIOS update, of course, but it looks like AMD is addressing the issue.

In addition to the 16GB HyperX Predator DDR4-3200 memory, we tested

all the boards with the flagship Ryzen 7 1800X. Graphics horsepower was provided by the GIGABYTE GeForce GTX 1080 Xtreme Gaming, while speedy storage was provided by the 480GB Patriot Hellfire.

Speaking of high-speed storage, AMD Ryzen processors have four dedicated PCIe 3.0 storage lanes to provide up to 32Gbps of bandwidth for PCIe and SATA SSDs. Almost all X370 and B350 motherboards include a 32Gbps M.2 slot. Unfortunately, neither the X370 nor B350 chipsets natively provide additional PCIe 3.0 lanes. Some X370 motherboards do offer a second M.2 port, but typically the additional M.2 port is only wired for PCIe 2.0 x4 (20Gbps) speed. No boards we reviewed have supported RAID over M.2 SSDs.

The AM4 platform does allow you to create RAID configurations with SATA devices, and the X370 chipset natively supports up to four 6Gbps SATA ports (in RAID 0, 1, and 10 configurations) and up to two SATA Express ports. The X370 chipset also provides eight general-purpose PCIe 2.0 lanes that can be used for additional connectivity, such as more SATA and USB ports. As you might expect, the native B350 chipset offers slightly less connectivity with just two 6Gbps SATA ports and six general-purpose PCIe 2.0 lanes.

Motherboard manufacturers add their own custom touches to the X370 and B350 chipsets that, for example, improve overclocking potential, sound quality, and network connectivity. With fewer free general-purpose lanes than Intel’s recent chipsets, it’s critical for manufacturers

X370 XPOWER GAMING TITANIUM

\$299 | MSI | us.msi.com

HEAVY GEAR

3.5 OUT OF 5

CPU



The image shows the MSI X370 XPOWER GAMING TITANIUM motherboard. It is a white PCB with black and silver accents. Key features visible include a large M.2 Shield, two PCIe 3.0 x16 slots, a PCIe 2.0 x1 slot, and a U.2 port. The board is densely populated with components, including a central processor socket, RAM slots, and various connectors. The MSI logo and a stylized dragon are printed on the board.

Specs: Max memory: 64GB DDR4 (DDR4-2667; Max OC: DDR4-3200); Slots: 2 PCIe 3.0 x16, 1 PCIe 2.0 x16, 3 PCIe 2.0 x1; Storage: 2 M.2 (slot 1 supports type 2242/2260/2280/22110, slot 2 supports 2242/2260/2280), 1 U.2, 6 6Gbps SATA; Rear I/O: 1 DisplayPort, 1 HDMI, 2 USB 3.1 (1 Type-C, 1 Type-A), 4 USB 3.0, 3 USB 2.0, 1 PS/2, 1 Ethernet, 1 S/PDIF, audio I/O, 1 Clear CMOS button; Form factor: ATX; Warranty: 3 years

to make smart use of what's available. We think all the motherboards in our roundup do a suitable job of adding value to the respective chipset.

MSI X370 XPOWER GAMING TITANIUM

We examined the Z270 XPOWER GAMING TITANIUM in last month's Z270 roundup, and as you might expect, MSI's X370 chipset variant offers a similar mix of high-end features for enthusiasts. Key reappearances include MSI's M.2 Shield that helps prevent thermal throttling with M.2 SSDs, additional power for the CPU socket and PEG slots, and immersive sound via Audio Boost 4 hardware and the Nahimic

2 audio suite. The X370 XPOWER GAMING TITANIUM isn't a carbon copy, though, and lacks some of the high-end amenities of the Z270 version, such as the OC Dashboard daughterboard for overclocking.

Despite not having all of the overclocking conveniences of its Z270 sibling, the X370 XPOWER GAMING TITANIUM is still a good option for enthusiasts considering a hefty Ryzen overclock. Completely digital power delivery and load-line calibration, for example, is onboard to ensure precise power delivery to the CPU. MSI includes both an 8-pin and 4-pin CPU power connector, so your Ryzen processor can receive more electrical current than a

board with only an 8-pin EPS connector. Similar to many other MSI boards, the X370 XPOWER GAMING TITANIUM features Military Class 5 components with titanium chokes and dark capacitors for VRM duties.

To quickly resolve any issues, there's a debug LED, as well as power, reset, clear CMOS, and BIOS flashback buttons. Speaking of the BIOS, we like the MSI includes a search feature in its BIOS interface, so you can quickly find the voltages and frequencies you want to adjust.

MSI provides one of the more detailed qualified vendor lists for memory compatibility you'll find, which is especially critical with AM4 boards as mentioned earlier. As of press time, MSI lists support for DDR4 modules as fast as DDR4-3200. This board is one where the benchmark numbers with our HyperX kit were slightly better with the kit's DDR4-2933 profile.

Similar to its Z270 sibling, the X370 XPOWER GAMING TITANIUM offers some power user extras for system storage. There are two M.2 ports, and the top slot comes with MSI's M.2 Shield and supports up to 32Gbps bandwidth. The second M.2 slot—powered by four PCIe 2.0 lanes—restricts bandwidth to 20Gbps, but we still like that MSI gives you the flexibility to install two M.2 devices. A U.2 port provides further high-speed storage options, while six 6Gbps ports offer connectivity for SATA SSDs and HDDs.

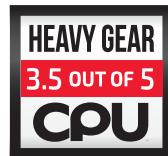
The X370 XPOWER GAMING TITANIUM was all-around performer with top scores in two games, the CPU-intensive POV-Ray 3.7, and the storage-intensive CrystalDiskMark 5.1.2. The board delivered the best frame rates in both Metro: Last Light (102fps) and Dying Light (144fps), and barely missed the top frame rate in Witcher 3 (74fps). The M.2 Shield appeared to have a positive effect on the 480GB Patriot Hellfire's speed, as the X370 XPOWER GAMING TITANIUM swept the

CrystalDiskMark results with the fastest sequential read/write and random 4K read/write numbers.

As of press time, the X370 XPOWER GAMING TITANIUM was the most expensive X370 chipset motherboard available on Newegg by \$45 and cost \$80 more than the majority of available X370 boards. The board's

X370 Taichi

\$209.99 | ASRock | www.asrock.com



Specs: Max memory: 64GB DDR4 (DDR4-2667; Max OC: DDR4-3200); Slots: 2 PCIe 3.0 x16, 1 PCIe 2.0 x16, 2 PCIe 2.0 x1; Storage: 2 M.2 (slot 1 supports type 2242/2260/2280, slot 2 supports 2230/2242/2260/2280), 10 6Gbps SATA; Rear I/O: 2 USB 3.1 (1 Type-C, 1 Type-A), 6 USB 3.0, 1 PS/2, 1 Ethernet, 1 S/PDIF, audio I/O, 2 antenna ports, 1 Clear CMOS button; Form factor: ATX; Warranty: 3 years

robust overclocking capabilities and impressive performance certainly make it worth consideration for performance enthusiasts, but if you're looking for an install-and-forget-it board, it might be worth taking a long look at more affordable options.

ASRock X370 Taichi

Balancing performance, connectivity, and cost on a motherboard is a tough job, one ASRock appears to be quite good at, based on the X370 Taichi. ASRock manages to include 12+4-phase power delivery, an external base clock generator, two M.2 ports, and onboard 802.11ac Wi-Fi for only \$209.99. We

ASRock engineers put in some extensive work into power delivery on the X370 Taichi. In addition to the 12+4-phase design, an IR (International Rectifier) digital power controller routes juice to the Ryzen processor, ideal for achieving optimal overclocks. Premium heat-resistant chokes are used for both the CPU and memory power to improve stability under load. ASRock's Hyper BCLK Engine II serves as the base clock generator and allows for BCLK up to 136MHz. Impressively, ASRock rates the board for up to 300-watt TDP overclocks.

When it comes to memory speed, ASRock qualifies a number of memory kits at DDR4-3200, and our test system quickly posted with the 16GB HyperX Predator kit running at 3,200MHz. But similar to MSI's X370 GAMING TITANIUM, scores were marginally better at the 2,933MHz profile.

For high-end GPU configurations, ASRock equips the X370 with two PCIe 3.0 x16 slots that support both SLI and CrossFire (or Quad-SLI and CrossFire with dual-GPU cards). We like that ASRock provides two slots' worth of space between them, as this layout improves airflow with two add-on cards. At the bottom of board, there's also a PCIe 2.0 x16 slot wired for x4 speed that shares bandwidth with the bottom M.2 slot. Installing an add-on card into the bottom PCIe x16 slot disables the second M.2 slot, and vice versa. We'd have preferred to see ASRock switch off the board's PCIe x1 slots and SATA ports.

The top M.2 slot is where you'll want to install your high-speed storage devices, because it has access to four PCIe 3.0 lanes. This M.2 slot is also compatible with ASRock's optional U.2 adapter, should your build plan call for a U.2 device. SATA connectivity is generous with a total of 10 6Gbps SATA ports. Eight of the ports support RAID 0, 1, and 10 configurations.

In our benchmark tests, the X370 Taichi was competitive across the board, yet the motherboard shined the brightest in SiSoftware Sandra 2017 processor tests. Top marks include the Dhrystone

AV2 (304.7GIPS) and Whetstone AVX (195.57GIPS) tests, as well as Multi-Media Integer (578.2Mpixels per second) and Multi-Media Quad ALU x1 (3.83Mpixels per second) tests. The X370 Taichi also went wild in The Witcher 3, with 75fps.

ASRock provides a lot of valuable power user additions to the X370 Taichi, so it has some undeniable appeal to enthusiasts on a budget. We also like that ASRock gives the board some overclocking chops. Hopefully more units will be available by the time you read this.

AORUS GA-AX370-Gaming K7

The GA-AX370-Gaming K7 is the AORUS flagship for the X370 chipset. Like all the AORUS boards we've reviewed thus far, RGB LEDs can be found along the PCB edges, under the heatsinks, and near the slots. Modders and enthusiasts in search of a "wow" factor won't find a much flashier option than the GA-AX370-Gaming K7. We also like that the LEDs can be split into multiple zones, including a separate zone for third-party RGB and RGBW light strips, to allow for accent colors. A plethora of performance additions are onboard, as well.

When Ryzen was first announced, the slightly more affordable GA-AX370-Gaming 5 was our first look at the X370 chipset. The AX370-Gaming K7 is similar in many ways, including support for a PCIe, NVMe M.2 (or U.2) SSD, four USB 3.1 ports on the rear panel, and 6+4-phase digital power delivery. Turbo B-Clock technology is the most notable addition to the GA-AX370-Gaming K7, as you can make linear adjustments to the BCLK all the way up to 300MHz. In essence, Turbo B-Clock provides you another way to overclock your Ryzen CPU.

GIGABYTE designs the AORUS GA-AX370-Gaming K7 to be extremely builder-friendly. There are eight 4-pin hybrid headers that will automatically detect if the connected device is a fan or water pump and will correspondingly dole out juice in PWM or voltage

mode. The GA-AX370-Gaming K7 features seven onboard temperature sensors, as well as two external temperature sensors that you can place anywhere inside your case. You can customize which sensor a particular fan/pump header will respond to, as well as fan speed profiles to ideally balance noise level and cooling performance.

source that compensates for voltage drop over long cable runs. Inside the BIOS, you can add up to 0.3V to the original USB output voltage, should you need to strengthen signal stability.

Gamers building a system around Ryzen should like the onboard audio and network amenities on the GA-AX370-Gaming K7. The board includes

AORUS GA-AX370-Gaming K7

\$209.99 | GIGABYTE | www.aorus.com



Specs: Max memory: 64GB DDR4 (DDR4-2667; Max OC: DDR4-3600); Slots: 2 PCIe 3.0 x16, 1 PCIe 2.0 x16, 3 PCIe x1; Storage: 1 M.2 (supports 2242/2260/2280/22110), 1 U.2, 8 6Gbps SATA, 2 SATA Express; Rear I/O: 1 HDMI, 4 USB 3.1 (1 Type-C, 3 Type-A), 6 USB 3.0, 1 PS/2, 2 Ethernet, 1 S/PDIF, audio I/O; Form factor: ATX; Warranty: 3 years

The GA-AX370-Gaming K7 comes with GIGABYTE's USB DAC-UP 2 technology to improve performance with VR headsets and other high-power USB hardware. USB DAC-UP 2 ports (the two yellow USB 3.0 ports on the rear panel, as well as the internal USB 3.0 headers) boast a dedicated power

two audio codecs (one for front-panel inputs and one for inputs on the rear panel) that support up to 120dB SNR and hardware decoding of DSD128. To avoid distortion with high-end headsets, there are smart headphone amplifiers that will automatically detect headset impedance and deliver an appropriate

sound fidelity level. There are two NICs onboard, one Killer E2500 and one Intel i211, should users prefer one NIC architecture over another.

3DMark's Fire Strike Extreme test had held all of the other boards in this roundup under an overall score of 9900. The GA-AX370-Gaming K7 wasn't having any of that, busting out an overall score of 10,062 that was highlighted by a Physics Score of 18701. This motherboard was also the top performer in SiSoftware Sandra 2017's Memory Bandwidth tests, producing a 34GBps score in both the Integer and Floating tests. Benchmark numbers were also excellent in the CPU-intensive Cinebench 15 and POV-Ray 3.7.

GIGABYTE continues to impress with the AORUS brand. The GA-AX370-Gaming K7 is an attractive motherboard with an eye toward extreme tweakers and gamers. We also like that this board had no performance drop when our HyperX kit was clocked at the 3,200MHz profile. It could have benefited from a second M.2 slot (all the other options in this roundup have a second M.2 slot), but there's plenty here to satisfy power users.

ASRock Fatal1ty AB350 Gaming K4

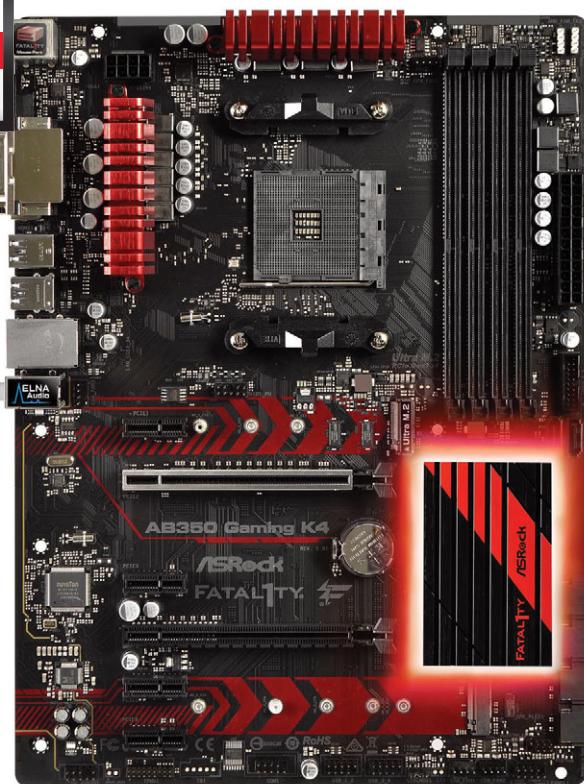
The Fatal1ty AB350 Gaming K4 is the one board in this roundup based on the B350 chipset. As a reminder, the B350 chipset limits support of dual-GPU setups and has fewer native SATA ports and general-purpose lanes. Otherwise, the B350 chipset supports much of the X370 chipset's connectivity, such as 32Gbps M.2 slots and overclocking for the Ryzen CPU and system memory.

In general, motherboards based on the B350 chipset have fewer overclocking amenities than the X370 chipset. ASRock, though, doesn't disregard overclocking as an option with the Fatal1ty AB350 Gaming K4. Similar to the X370 Taichi, power delivery is completely digital and passes through premium power chokes. The Gaming K4 also boasts a 6+3 power phase design. ASRock has qualified the board to support DDR4 memory at up to

Fatal1ty AB350 Gaming K4

\$109.99 | ASRock | www.asrock.com

HEAVY GEAR
4.0 OUT OF 5
CPU



Specs: Max memory: 64GB DDR4 (DDR4-2667; Max OC: DDR4-3200); Slots: 2 PCIe 3.0 x16, 4 PCIe 2.0 x1; Storage: 2 M.2 (slot 1 supports type 2242/2260/2280, slot 2 supports 2230/2242/2260/2280/22110), 6 Gbps SATA; Rear I/O: 1 HDMI, 1 DVI-D, 1 VGA, 6 USB 3.0 (1 Type-C, 5 Type-A), 2 USB 2.0, 1 PS/2, 1 Ethernet, audio I/O; Form factor: ATX; Warranty: 3 years

3,200MHz, and you can install up to 64GB of system memory.

Most B350 chipset motherboards include one 32Gbps M.2 port, but that's generally the extent of M.2 support. The Fatal1ty AB350 Gaming K4 provides a second M.2 port where you can install a SATA M.2 SSD. This M.2 port would be ideal for a large capacity M.2 drive serving as file storage. The board also features six 6Gbps ports, some of which will be disabled if you install a drive into the bottom SATA M.2 slot.

ASRock equips the Fatal1ty AB350 Gaming K4 with two PCIe 3.0 slots—and as is standard for the B350 chipset—these slots operate differently than the X370 chipset. The top slot

is wired for the full PCIe 3.0 x16 bandwidth, while the second x16 slot works electrically at PCIe 2.0 x4 speed. If you install an M.2 SSD in the top M.2 slot (the 32Gbps slot), the Gaming K4 will also disable the second PCIe x16 slot. In short, it's likely power users will want to stick with a single-GPU setup, but the same is true for most other B350 chipset boards.

The Fatal1ty AB350 Gaming K4 has a number of features to enhance the gaming experience. There's a Key Master utility, for example, that lets you create macros, sniper modes, and repeat delays on your mouse and keyboard. For immersive sound, ASRock adds Creative's Sound Blaster Cinema 3 with

Reality 3D technology that brings virtual surround sound to stereo headphones or speakers. You can customize the audio experience via the SBX Pro Studio software.

Benchmark-wise, the Fatal1ty AB350 Gaming K4 was always going to struggle against the higher-priced X370 chipset boards. But despite not winning any of the tests, if you scan through the results, you'll see there's hardly any drop-off in most of our tests. It's clear that the motherboard can produce top-notch numbers when paired with high-end components.

Budget-minded enthusiasts who don't plan on using a dual-GPU setup should certainly consider the B350 chipset. The Fatal1ty AB350 Gaming K4 is one of the more capable B350 chipset motherboards on the market. And at \$109.99, it's \$100 less than the least expensive X370 option in this roundup.

The AMD Adventure Continues

With the recent release of Ryzen 5 processors (and the expected release of Ryzen 3 processors later this year), AMD continues to fill out its CPU roster at all price points. A Ryzen 7 chip is still likely the best pairing for MSI's X370 XPOWER GAMING TITANIUM and its overclocking features. The ASRock X370 Taichi is also overclock-ready and is quite a bit more affordable. The AORUS GA-AX370-Gaming K7 is feature-rich for gamers and would go well with any Ryzen chip. Need to shave some budget off your Ryzen build and still want performance? Consider the well-designed ASRock Fatal1ty AB350 Gaming K4 and a Ryzen 5 processor. ■

Benchmark Results	MSI X370 XPOWER GAMING TITANIUM	ASRock X370 Taichi	AORUS GA-AX370-Gaming K7	ASRock Fatal1ty AB350 Gaming K4
MSRP	\$299	\$209.99	\$209.99	\$109.99
3DMark Fire Strike Extreme	9859	9854	10062	9841
Graphics Score	10404	10424	10616	10388
Physics Score	18099	17629	18701	17989
Graphics Test 1	54.52	54.58	55.76	54.52
Graphics Test 2	38.65	38.75	39.38	38.55
PCMark 8				
Creative Score	5813	5729	5710	5640
SiSoftware Sandra 2017				
Dhrystone AVX2 (GIPS)	298.74	304.7	301.47	303.85
Whetstone AVX (GFLOPS)	195.37	195.57	195.5	195.08
Multi-Media Integer AVX2 x32 (Mpixels/s)	570.26	578.32	571.63	574.33
Multi-Media Long-int AVX2 x16 (Mpixels/s)	168.4	167.89	169.91	155.16
Multi-Media Quad ALU x1 (Mpixels/s)	3.72	3.83	3.79	3.77
Integer B/F AVX/128 (GBps, memory bandwidth)	32.36	28.32	34	28
Floating B/F AVX/128 (GBps, memory bandwidth)	33.07	28.33	34	28.1
CrystalDiskMark 5.1.2 (MBps)				
Sequential Read (Q32T1)	2378	2294	2305	2290
Sequential Write (Q32T1)	1205	1193	1108	881.9
Random 4K Read (Q32T1)	270.4	237.1	256.9	235.6
Random 4K Write (Q32T1)	200.7	196	197.8	195.6
POV-Ray 3.7 (Pixels/s)	3394	3380	3390	3377
Cinebench 15 (Points)	1621	1608	1625	1609
Games (2,560 x 1,440)				
Metro: Last Light (Very High, 16xAF; SSAO off)	102fps	101fps	96fps	100fps
Dying Light (High, AO On, AA On, Vsync Off)	144fps	143fps	141fps	143fps
Witcher 3: Wild Hunt (Vsync Off, Unl. FPS, Ultra)	74fps	75fps	73fps	72fps

BY NATHAN LAKE

THE BEAUTY OR THE BEAST WHY CHOOSE?



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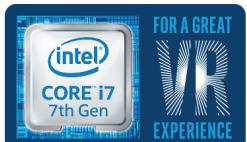
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As PC gaming and VR continues to move into the mainstream, there's a real need for high-end computers that look the part in the social spaces of your home. And although we love big rigs with colorful liquid cooling loops, custom paint jobs, and panels that show off the high-end hardware, we know that such builds aren't for everyone and generally don't mesh well with modern interior design. The Trident 3 Arctic assimilates into a home theater without a second glance. Inside this console-sized chassis is an Intel Core i7-7700, an NVIDIA GeForce GTX 1070, and 16GB of DDR4-2133 memory—more than enough to power the VR experience and games.

The Trident 3 Arctic's dimensions (2.83 x 13.63 x 9.15 inches [HxWxD]) are extremely close to a PlayStation 4 Pro, and the whole system only weighs 6.9 pounds, so you could conceivably carry it in a backpack. MSI also includes a stand, so the system can sit vertically if necessary. The Arctic version, obviously, features a bright white exterior. MSI even installs white vents, and there are vents on almost every side to allow for airflow—no matter if you lay the PC down or sit it up.

It's easy to access the ports you'll need. The front panel includes a separate headphone output and microphone input, which helps to avoid audio issues that can occur with a combo jack. There are also two USB 3.0 Type-A ports (standard connector), a USB 3.0 Type-C port (reversible connector), and a VR Link port. The latter is a front-facing HDMI port that's ideal for connecting a VR headset. When you do, MSI's GAMING Center software will auto-detect it and optimize system settings for VR performance. If you're in need of more ports, the rear panel provides another USB 3.0 port, four USB 2.0 ports, an Ethernet jack (Intel i219V NIC), and additional audio I/O.

Under the hood, the Trident 3 Arctic features a full complement of power user hardware. The previously mentioned GeForce GTX 1070 comes with 8GB of GDDR5 memory, which is important because VR games often recommend more than 4GB of video memory. The storage subsystem boasts a 256GB Intel SSD 600p Series for the OS drive and a 1TB Hitachi Travelstar for file storage. The motherboard is a proprietary MSI design

based on the H110 chipset. Wireless connectivity is onboard, too. The Trident 3 Arctic comes with an Intel Dual Band Wireless-AC 3165 module that supports both 802.11ac and Bluetooth 4.2.

The Trident 3 Arctic is a solid gaming platform and is designed to seamlessly work with your home theater environment. MSI ensures support for Xbox Play Anywhere and Playstation Now, should you already own a console title and want to play on the high-end Trident 3 Arctic hardware. MSI also indicates you can play with a controller, if you prefer it over a keyboard and mouse.

Unlike a console, you'll also be able to upgrade the Trident 3, as MSI allows you to access the key hardware, such as the storage or graphics card, to keep up with future hardware requirements. On the side opposite the power button, there's a slight indentation on the panel cover, which gives you access to the screws that keep the chassis cover in place. Once you remove the screws, it's easy to access the various components.

Any hardware going into a home theater environment will need to be extremely quiet. MSI equips the



Left image: MSI includes a stand with the Trident 3 Arctic, so you can position the system vertically if you wish. Front I/O includes two USB 3.0 Type-A ports, a USB 3.0 Type-C port, a VR Link port, a mic input, and a headphone output. Right image: The rear panel of the Trident 3 Arctic provides one USB 3.0 port, four USB 2.0 ports, an Ethernet jack (Intel i219V NIC), and some additional audio I/O.

Trident 3 with its Silent Storm Cooling 2, which is a design that separates the various heat generating components into different chambers with their own airflow. The biggest vent on the Trident 3, for example, serves as a GPU intake fan, and the GeForce GTX 1070 pushes hot air out the rear panel and a vent in the side panel. Smart thermal design allows the Trident 3 Arctic to keep noise levels under 36dB(A) at full load. In idle, MSI rates the Trident 3 Arctic for a noise level of 25dB(A).

We reviewed MSI's first Trident iteration back in November of last year, and the initial Trident boasted a GeForce GTX 1060 3GB GPU and an Intel Core i7-6700. The Trident 3 Arctic's upgraded hardware—the GeForce GTX 1070, in particular—made a big difference in our benchmark results. For example, frame rates in the Witcher 3 jumped from 36fps to 57fps, while Metro: Last Light (82fps)

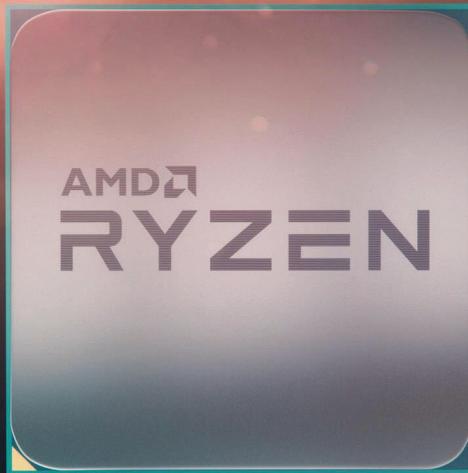
and Dying Light (84fps) were both well over 60fps. There was also a big boost in 3DMark's Fire Strike Extreme test with an overall score of 7986—up from 5200 on the original Trident.

MSI continues to improve its Gaming Desktop lineups, and the Trident 3 Arctic is a good example of how MSI is challenging how we think about small form factor systems. As in the high-end notebook world—where size constraints call for more costly, customized designs—the Trident 3 Arctic (\$1,499) comes at a slight price premium, especially if you compare costs with similar components. But you'd be hard pressed to find a small form factor case that will look as nice inside a home theater as the console-sized Trident 3 Arctic. ■

BY NATHAN LAKE

Benchmark Results	
3DMark Fire Strike Extreme	7986
Graphics Score	8662
Physics Score	12732
PCMark 8	
Creative Score	5561
SiSoftware Sandra 2017	
Dhrystone AVX2 (GIPS)	186
Whetstone AVX (GFLOPS)	108.21
Multi-Media Integer AVX2 x32 (Mpixels/s)	517
Multi-Media Long-int AVX2 x16 (Mpixels/s)	190
Multi-Media Quad ALU x1 (Mpixels/s)	2
Floating B/F AVX/128 (GBps, mem bandwidth)	24.38
CrystalDiskMark 5.1.2 (MBps)	
Sequential Read (Q32T1)	1478
Sequential Write (Q32T1)	592.8
Random 4K Read (Q32T1)	289.8
Random 4K Write (Q32T1)	403.8
POV-Ray 3.7 (Pixels/s)	1889.21
Cinebench 15 (Points)	878
Games	(2,560 x 1,440)
Metro: Last Light (Very High, 16xAF; SSAA off)	82fps
Dying Light (High, AO On, AA On, Vsync Off)	84fps
Witcher 3: Wild Hunt (Vsync Off, Unl. FPS, Ultra)	57fps

System Specs: Processor: Intel Core i7-7700; Chipset: Intel H110; GPU: NVIDIA GeForce GTX 1070 8GB; Memory: 8GB DDR4-2400; Storage: 256GB Intel SSD 600p Series, 1TB Hitachi Travelstar; OS: Windows 10 Home 64-bit; Warranty: 2 years



Ryzen 5 1600X
\$249
AMD
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AMD Ryzen 5 1600X

Last month we took the shrink wrap off the eight-core Ryzen 7 CPUs, and now it's the six-core Ryzen 5 1600X's turn to upend the sub \$300 processor market.

The Ryzen 5 1600X is based on the same Summit Ridge architecture in the Ryzen 7, and in an unprecedented feat of engineering, the architecture of the Ryzen processors realized a 52% increase in IPC (instructions per clock) compared to Bulldozer. Just like in the Ryzen 7s, there are two quad-core CCX (CPU Complex) units in the Ryzen 5 1600X, but one core in each module has been disabled for a 3+3 CCX configuration. SMT is turned on and lets the processor handle up to twelve concurrent threads. These units are mounted to AMD's Infinity Fabric, which refers to the interface and bus that lets the modules, cores, and caches exchange data with

the system memory, I/O, and PCIe devices. This chip features a 192mm² die consisting of 4.8 billion transistors, and it is manufactured on Global Foundry's 14nm FinFET process.

The Ryzen 5 1600X is a thirsty processor, and to keep its cores hydrated,

to spare. Two of the six cores can boost up to 4GHz for those poorly-threaded applications, and the Ryzen 6 1600X also enjoys another 100MHz XFR boost to those cores when conditions allow.

To make sure this constantly shifting clockspeed provides tangible benefits, AMD has deployed a smart grid of interconnected sensors within each Ryzen processor capable of granular reporting of power and temperatures, up to a thousand times per second. Pure Power, Precision Boost, and the aforementioned XFR, which account for 3/5ths of AMD's SenseMI technologies, let each Ryzen processor tune

its power consumption behavior to the silicon's specific capabilities. Clockspeed adjustments occur in 25MHz increments, and performance is directly tied to the cooling capacity of your hardware. This

The Ryzen 5 1600X is a beast when it comes to single- and multi-threaded applications.

there's a sizeable 512KB L2 cache per core and 16MB of L3 cache shared between cores. The core clock is set to 3.6GHz and the processor can boost all of its cores to 3.7GHz when there's TDP headroom



processor doesn't ship with a CPU cooler, and our testing was performed using the EK-XLC Predator 240 AIO liquid cooler, which gave us plenty of thermal runway to really get this processor flying. The two SenseMI technologies not directly related to clockspeed adjustments are Neural Net Prediction and Smart Prefetch, which aim to assist in preloading necessary instructions into cache, anticipating the location of future data calls, and determining the best route for data to travel through the processor.

Even though it has two fewer cores to work with, the Ryzen 5 1600X is still a 95-watt processor, just like the Ryzen 7 1800X. There's an onboard dual-channel DDR4 memory controller that supports speeds up to 2,666MHz with two single-rank DRAM modules. However, with the help of an overclocked memory profile, we were able to test the processor with a 16GB GeIL EVO X kit clocked at 3,200MTps. In our initial Ryzen 7 review, we mentioned that motherboard memory

support would improve in the subsequent weeks and months, and our testing of this processor appears to bear that out.

In a move that's already making waves among enthusiasts, AMD chose to carry forward its practice of unlocking its processors for overclocking, and as long as you're using an X370 or B350 chipset-based motherboard, moving the multiplier to give Ryzen a healthy boost is easy. With the Ryzen 5 1600X installed in our MSI X370 XPOWER GAMING TITANIUM, we managed to improve our scores almost across the board with a six core clock set at 4GHz, with a 1.4V core voltage enabled in the UEFI setup menu.

The Ryzen 5 1600X is a beast when it comes to single- and multi-threaded applications, and

compared to the three Ryzen 7 processors we've tested, its gaming chops are just as impressive. At half of the price of the flagship Ryzen 7 processor, this chip makes a compelling case for itself. ■

BY ANDREW LEIBMAN

	Ryzen 5 1600X	4GHz OC
3DMark Fire Strike Ext.	10318	10443
Graphics Score	11046	11128
Physics Score	17139	18390
Graphics Test 1	58.77fps	59.16fps
Graphics Test 2	40.6fps	40.93fps
Physics Test	54.41fps	58.38fps
Combined Test	22.96fps	23.03fps
PCMark 8 Creative Score	6152	6158
Sandra 2016 Lite		
Dhrystone Integer Native AVX2 (GIPS)	225.66	243.57
Whetstone Single-float Native AVX (GFLOPS)	145.13	158.07
x32 Multi-Media Integer AVX2 (Mpixels per second)	423.61	451.36
x16 Multi-Media Long-int AVX2 (Mpixels per second)	125.9	135.64
x1 Multi-Media Quad ALU (Mpixels per second)	2.83	3.1
x16 Multi-Media Single-float FMA (Mpixels per second)	403.69	443.52
Integer Memory Bandwidth B/F AVX/128 (GBps)	36.73	36.2
Float Memory Bandwidth B/F AVX/128 (GBps)	36.66	36.36
Cinebench 15 (Points)	1246	1335
POV-Ray 3.7 (Ppxs)	2572.59	2758.86
Sniper Elite 4 (Vsync Off, Ultra, DX11)	118.93fps	113.4fps
The Witcher 3 (Vsync off, Uni.fps, Ultra)	79.46fps	80.52fps

Test System Specs: Processor: AMD Ryzen 5 1600X (3.6GHz Base, 4GHz P. Boost); Motherboard: MSI X370 XPOWER GAMING TITANIUM; Graphics Card: GIGABYTE GTX 1080 Xtreme Gaming; RAM: GeIL EVO X DDR4-3000; Storage: 240GB Kingston HyperX SSD; OS: Windows 10 Enterprise 64-bit



GIGABYTE AORUS GeForce GTX 1080 Ti 11G

As much as we love new GPU launches, there's always that dead period right after the reference design models launch but just before the AIBs have had a chance to take off the training wheels and really let the silicon sing. As we go to press, that dead period is over for the GTX 1080 Ti, and the first custom card we've been able to test is GIGABYTE's AORUS GeForce GTX 1080 Ti 11G.

This card features the 16nm FinFET-based GP102, created with 12 billion transistors. There are 28 Streaming Multiprocessors, 3,584 CUDA Cores, 224 texture units, and 88 ROPs. NVIDIA combined eleven 32-bit memory controllers for a 352-bit wide memory bus, which is paired with 11GB of GDDR5X clocked at 11,010MHz (effective). The Founder's Edition 1080 Ti has

base and boost clocks set to 1,480MHz and 1,582MHz, respectively. That makes this gaming behemoth capable of 11.4TFLOPS of raw compute and 484GBps memory bandwidth, which is a few percentage points faster than the TITAN X. Compared to the reference design card, the AORUS 1080 Ti simply soars.

In its default Gaming Mode, the base and boost clocks are locked in at 1,569MHz and 1,683MHz. When you install the AORUS GRAPHICS ENGINE (formerly the Xtreme Gaming Engine) utility, you can unlock OC Mode to raise the base and boost clocks to 1,594MHz and 1,708MHz, which is up to 228MHz faster than the reference design. This is the setting we tested the card at, and as you can see from the scores, 4K is where this card feels most at home.

The only real complaint we had with the Founder's Edition GTX 1080 Ti was its rather noisy blower-style cooler. To keep the AORUS 1080 Ti running cool and quiet, GIGABYTE modified its Xtreme Gaming WINDFORCE cooler so that now there's a copper core behind the GPU built into the card's brushed aluminum backplate. Over the top of the GPU and memory chips, GIGABYTE has installed a large copper baseplate. On top of that, there's a heatsink with angled fins threaded with GIGABYTE's composite vapor-chamber-like heatpipes. The middle fan in the trio of stacked double ball bearing fans spins the opposite direction, which spreads cool air over more of the card's surface. There's also some visual flair in the form of RGB LED-backlit AORUS and Fan Stop

CPU RANKING 0 = ABSOLUTELY WORTHLESS 2.5 = ABSOLUTELY AVERAGE 5 = ABSOLUTELY PERFECT



logos on the top edge of the card and a quartet of RGB LED bars on the face of the card.

The cooler isn't the only custom component in this package. The PCB features a 12+2 phase VRM, as well as high-quality TITAN X-grade chokes and capacitors, and an aerospace-grade coating prevents dust buildup, resists component corrosion, and acts as a moisture barrier.

There is a plethora of outputs on this card, including three full-sized DisplayPort 1.4 and one dual-link DVI-D outputs. When it comes to HDMI, the AORUS VR Link feature lets you utilize two of the rear-facing HDMI ports, or utilize the card's internal HDMI port for connecting to a VR headset to a front panel-based output.

We've already declared the GTX 1080 Ti the definitive 4K gamer's graphics card, making the tangibly faster AORUS GTX 1080 Ti 11G . . . even more definitive. Definitely. ■

BY ANDREW LEIBMAN

AORUS GeForce GTX 1080 Ti 11G

\$719.99

GIGABYTE

www.gigabyte.us

Specs & Scores	NVIDIA GeForce 1080 Ti F.E.	AORUS 1080 Ti 11G (OC Mode)
Base clock	1,480MHz	1,594MHz
Boost clock	1,582MHz	1,708MHz
Memory clock	2,753MHz	2,753MHz
Memory interface	352-bit	352-bit
Memory	11GB GDDR5X	11GB GDDR5X
3DMark Fire Strike Ex.	11,806	13,274
Graphics Score	13,304	14,018
Physics Score	24,781	21,430
Games	(1,920 x 1,080)	
Shadow Of Mordor (Vsync Off, Ultra, DoF, OIT, Tess)	195.35	200.8
Metro: Last Light (DX11, V High, 16XAF, V High Tess.)	167.33	165.33
Dying Light (High, AO On, AA On, Vsync Off)	222.29	185.42
Witcher 3: Wild Hunt (Vsync off, Unl. fps, Ultra)	146.29	141.16
	(2,560 x 1,440)	
Shadow Of Mordor (Vsync Off, Ultra, DoF, OIT, Tess)	145.58	155.1
Metro: Last Light (DX11, V High, 16XAF, V High Tess.)	113.33	120.67
Dying Light (High, AO On, AA On, Vsync Off)	163.04	163.98
Witcher 3: Wild Hunt (Vsync off, Unl. fps, Ultra)	109.74	117.06
	(3,840 x 2,160)	
Shadow Of Mordor (Vsync Off, Ultra, DoF, OIT, Tess)	79.76	87.65
Metro: Last Light (DX11, V High, 16XAF, V High Tess.)	67	69.33
Dying Light (High, AO On, AA On, Vsync Off)	79.48	86
Witcher 3: Wild Hunt (Vsync off, Unl. fps, Ultra)	59.87	61.483

HEAVY GEAR

2.5 OUT OF 5

CPU



ARCTIC Freezer 12

Over the years, air coolers have gained a reputation as being louder than their liquid-cooling counterparts. There are, of course, many excellent low-noise air coolers on the market, but most of the quiet heatsink/fan combos feature tall (and sometimes wide) heatsinks and multiple noise-optimized fans. Near-silent acoustics with a small air cooler is a challenge, which makes the ARCTIC Freezer 12 all the more impressive. This compact CPU cooler boasts a semi-passive design with a 92mm fan that only starts to spin when the PWM signal is above 40%. And even under full load, ARCTIC only rates the 92mm fan for 0.3 Sone (roughly 22dBA).

The Freezer 12 is a follow-up to ARCTIC's Freezer i11 family, which also offers low-noise design but not a passive cooling mode. Notably, ARCTIC also adds support for AMD's AM4 socket—the Freezer i11 only supports recent Intel sockets. ARCTIC rates the Freezer 12 for a TDP of up to 150 watts, so it should support the

high-end Intel and AMD processors. Ryzen 7 CPUs, for example, have a 95-watt TDP, while the Intel Core i7-7700K features a 91-watt TDP. ARCTIC must be fairly confident in the cooler's reliability, as the company supports it with a six-year warranty.

On the Freezer 12, ARCTIC also improves fan efficiency at the boundary level, resulting in better performance at lower fan speeds. Plastic clips built into the included 92mm fan make it a breeze to snap the fan on and off. With an Intel processor, the mounting system allows you to orient the Freezer 12's heatsink in any direction. As such, the 92mm fan can direct airflow to the top or rear of the case, as well as serve as an intake or exhaust. Those on AMD's AM4 platform can only orient the fan to the rear of the case, because the Freezer 12 is only designed to use the metal backplate for the new AMD socket.

The Freezer 12's heatsink features three 6mm heatpipes that make direct contact with the CPU—a common design among

Freezer 12

\$39.99

ARCTIC

www.arctic.ac

modern air coolers. ARCTIC includes its MX-4 thermal paste for excellent thermal conductivity. The compact heatsink should fit into all but the smallest form factor cases with dimensions of 5.1 x 4.3 x 3.5 inches (HxWxD).

We installed the Freezer 12 into a system with Intel's Core i7-7700K and an AORUS GA-Z270X-Gaming 7 motherboard. Idle temps, on average, were 35.8 degrees Celsius, which is a bit higher than normal, but an expected result because the 92mm fan was running at minimal rpms. POV-Ray 3.7 testing pushed average temperatures to 78.5 C with a maximum of 85 C. With testing load, of course, fans were running at the maximum 2,000rpm. Lastly, we ran Prime95's Small FFT torture test for 10 minutes. This demanding load pushed average temperatures to 96 C, and the Core i7-7700K throttled to a lower speed after five minutes of testing.

ARCTIC's Freezer 12 may not have been able to handle the heavy stress of Prime95, but it did sufficiently well with POV-Ray 3.7. Near-silent—and sometimes completely silent—operation is the most compelling reason to purchase the Freezer 12, and the small footprint could be a big bonus for builders working on a small form factor rig. ■

BY NATHAN LAKE

Specs: Materials: Copper (base, 6mm heatpipes), aluminum (fins); Fan: 92mm PWM (0 - 2,000rpm); Cooler dimensions: 5.1 x 4.3 x 3.5 inches; Socket compatibility: Intel LGA 775/115X/1366/2011(3), AMD AM4; Warranty: 6 years

Test system specs: Intel Core i7-7700K; Motherboard: AORUS GA-Z270X-Gaming 7; GPU: GIGABYTE GeForce GTX 1080 Xtreme Gaming; Memory: Corsair Vengeance LED 32GB DDR4-3200MHz; Storage: 480GB Patriot Hellfire; OS: Windows 10 Enterprise

CPU RANKING 0 = BELOW AVERAGE 2.5 = AVERAGE 5 = PERFECT

HEAVY GEAR

4.0 OUT OF 5

CPU



SAPPHIRE NITRO+ Radeon RX 580 8GB Limited Edition

As part of AMD's attempt to roll out the red carpet for Vega later this year, we're getting a refreshed line of graphics cards in the 500 Series. The SAPPHIRE Radeon RX 580 NITRO+ Limited Edition is Polaris, refined, enhanced, and ever-so-slightly tweaked.

This is not a new architecture, these are the same fourth-generation GCN (Graphics Core Next) architecture-based GPUs manufactured on Global Foundries' 14nm FinFET process. The GPU inside the RX 580 measures 232mm² and it has the same 36 compute units as 2016's RX 480. There are 2,304 stream processors, 144 texture units, and 32 ROPs. Again, there are 4GB and 8GB GDDR5-enabled RX 580s, and they both feature a 256-bit memory bus. The RX 580 has its reference base and boost clocks set to 1,257MHz and 1,340MHz, respectively. In short, the only thing "new" about these cards is the higher clocks. There are 500 million gamers—by AMD's count—who're running a two-year-old or older graphics card, and it's these folks who can see the biggest improvement from a 500 Series upgrade.

This card's gunmetal grey heatsink shroud, a color exclusive to the Limited Edition, looks familiar on the outside, but the underlying Dual-X heatsink is bigger and better, featuring four nickel-plated copper heatpipes, more robust VRM cooling, and a 54-fin heatsink. All told, the cooler lets the card run up to 12dbA quieter. Out of the box, the card features

two black 95mm dual ball-bearing fans, but the Limited Edition ships with a set of frosted translucent fans with blue LEDs. It took us less than five minutes to swap them out, and the extra illumination, although not RGB, was a nice touch. The SAPPHIRE logo is RGB-controllable, however, and SAPPHIRE's NITRO Glow feature lets you vary the color by fan speed or GPU temperature, cycle through colors, or run with the static color of your choice.

The Limited Edition also has a dual BIOS switch on the top edge that lets you choose between the NITRO+ clock of 1,411MHz, or the Limited Edition clock of 1,450MHz. This is clearly a binned chip, and we are pleased to report that the card remains fairly quiet under load, even when running at the higher core clock. In order to feed this card with enough juice to maintain those clocks, there are 8-pin and 6-pin PCIe power ports on the top edge of the card. Display outputs on the back bracket include two HDMI, two DP, and one DVI port.

Last year's Radeon RX 480 was capable of running our games at a playable 1440p, but only just. The NITRO+ Radeon RX 580 Limited Edition feels much more at home at this resolution. The Limited Edition extras are great for fanatics, but at \$249, the vanilla NITRO+ feels like the ideal option for a vast majority of gamers in search of a 2017 upgrade. ■

BY ANDREW LEIBMAN

Test System Specs: Processor: Intel Core i7-6950X; Motherboard: GIGABYTE GA-X99-Ultra Gaming; Memory: 16GB HyperX Predator DDR4-3000; Storage: 240GB OCZ Vertex 3 MAX IOPS SSD; OS: Windows 10 Enterprise

NITRO+ Radeon RX 580 8GB Limited Edition

\$279

SAPPHIRE

www.sapphiretech.com

Specs & Scores	NITRO+ Radeon RX 580 8GB L.E.
Base clock	1,411MHz
OC clock	1,450MHz
Memory clock	2,000MHz
Memory interface	256-bit
Memory	8GB GDDR5
3DMark Fire Strike Ex.	6,008
Graphics Score	6,200
Physics Score	21,108
Games	(1,920 x 1,080)
Shadow Of Mordor (Vsync Off, Ultra, DoF, OIT, Tess)	95.45fps
Metro: Last Light (DX11, V High, 16XAF, V High Tess.)	89.33fps
Dying Light (High, AO On, AA On, Vsync Off)	103.14fps
Witcher 3: Wild Hunt (Vsync off, Unl. fps, Ultra)	74.97fps
	(2,560 x 1,440)
Shadow Of Mordor (Vsync Off, Ultra, DoF, OIT, Tess)	67.78fps
Metro: Last Light (DX11, V High, 16XAF, V High Tess.)	57.33fps
Dying Light (High, AO On, AA On, Vsync Off)	71.3fps
Witcher 3: Wild Hunt (Vsync off, Unl. fps, Ultra)	52.11fps
	(3,840 x 2,160)
Shadow Of Mordor (Vsync Off, Ultra, DoF, OIT, Tess)	37.26fps
Metro: Last Light (DX11, V High, 16XAF, V High Tess.)	28.67fps
Dying Light (High, AO On, AA On, Vsync Off)	36.78fps
Witcher 3: Wild Hunt (Vsync off, Unl. fps, Ultra)	28.48fps



Patriot Viper V570 Gaming Mouse

Last year, we found Patriot's Viper V560 Laser Gaming Mouse to be a feature-packed mouse for a surprisingly affordable price. Since then, the company best known for its memory products released the more budget-minded V530 LED Gaming Mouse, and now, after a bit of a delay, it's time for the full-featured Viper V570 Gaming Mouse to sneak out of its hole.

The design of this mouse vaguely resembles that of the V560; it has a rubberized pad for your thumb to rest on, the DPI buttons are in roughly the same place between the right and left mouse buttons, and this is clearly a right-handed mouse. The swappable right side panel is gone, however, and in its place the side of the mouse features a subtle bulge to keep your ring finger and pinky in place. The surface of the mouse is covered in matte black plastic, with a rectangular glossy panel on top of the device where you'll find one of the RGB LEDs. There are six other RGB LEDs on the mouse, and you can use the Viper software to synchronize them or create your own LED color scheme.

The four LED-lit DPI indicators are adjacent to the DPI switches, and there's a row of seven programmable buttons that span the left side of the mouse, above the thumb. At the top of the thumb's resting position is a sniper button, which dramatically reduces the DPI setting (to 400DPI) for those times when you need pinpoint accuracy in games. We've also found the button ideal for making fine adjustments to images using various Photoshop tools. In total, there are 13 programmable buttons on the Viper V570. The LED-lit mouse wheel features a rubber no-slip grip down the center, and there are five ceramic foot pads that provide minimal friction on virtually any surface.

You can snap off a top portion of the mouse housing to access the hidden weight compartment, letting you add up to 34.2 grams. That's enough to make this fairly light mouse feel like a brick in your hand, which is good for making sure the cursor stays put even after adjusting your grip.

Under the housing, Patriot equipped this mouse with an Avago 9800 laser

sensor, letting you adjust the DPI to up to 12,000. The rest of the switches are zero-delay Omron switches. One of the unique features we like about the Viper V570 is the software-enabled Auto-Speed feature, which lets the mouse bounce between two preset DPI settings, depending on the detected mouse movement. You can set Auto-Speed ranges for each of the four DPI profiles stored on the device. We also like that the mouse is customizable enough to be used as an MMO mouse, but there aren't so many buttons on it that they get in the way when using it for other computing tasks.

Patriot crammed a lot of premium features into the Viper V570 Gaming Mouse, but still managed to keep the price reasonable. We're impressed, again. ■

BY ANDREW LEIBMAN

Viper V570 Gaming Mouse

\$59.99

Patriot

www.patriotmemory.com

Specs: Sensor: Avago 9800 Laser (50 to 12,000 DPI); Body Type: right-handed; LEDs: 16.8 million color RGB lighting in seven zones; Adjustable weight system; 13 programmable buttons; Macros: Yes; Onboard Memory: Yes; Interface: gold-plated USB; Cable: braided red and black nylon

HEAVY GEAR

3.5 OUT OF 5

CPU



ROG Swift PG27AQ

\$799

ASUS

www.asus.com

ASUS ROG Swift PG27AQ

Most PC users tend to upgrade their graphics card, processor, motherboard, and memory at a faster clip than they do their monitors. But as a result, many are using a display that's rather long in the tooth. If you're considering a new monitor, the ASUS ROG Swift PG27AQ should be on your short list, as it is loaded with eye-popping reasons to upgrade.

The centerpiece of this bold and beautiful monitor is the 27-inch UHD (3,840 x 2,160) resolution IPS (in-plane switching) panel. For those upgrading from a 1,080p display, the PG27AQ delivers 300% more desktop real estate but retains the 16:9 widescreen aspect ratio. The 8.3-megapixel panel features a 0.155mm pixel pitch, which means that there are 163 pixels per square inch. With such a high pixel density, you can be assured that no matter what you're viewing, it'll appear crisp, vivid, and true-to-life. This IPS panel is ideally suited to gaming with its 4ms gray to gray response time, 1,000:1 contrast ratio, 300cd/m² brightness, and 178 degree vertical and horizontal viewing angles. When it comes to colors, this monitor also shines, it features a 10-bit panel capable of displaying 1.07 billion colors

and supports color reproduction based on 100% of the sRGB color space. Like most 4K monitors on the market today, this one is limited to a 60Hz refresh rate.

If you've ever noticed LED-backlight-induced flickering, then you know how disrupting it can be. ASUS has solved the issue with its Flicker-Free technology, making everything you watch on the PG27AQ look smooth.

Gamers running a GeForce GTX 980 or higher can tap into another of this monitor's smoothing technologies, NVIDIA G-SYNC. This lets the monitor employ a variable refresh rate, whereby the graphics card dictates how often the screen draws an image. This eliminates the ever-present screen tearing that occurs when framerates and screen refresh rates fall out of sync, and it does so without the stuttering that the Vsync setting introduces.

The ROG Swift PG27AQ features a 5-way joystick on the backside of the right-edge, which makes navigating the OSD simple and fast. There's a button dedicated to the ASUS GamePlus extras, which let you superimpose one of four different crosshairs, display an FPS counter, or enable an onscreen timer. This monitor also supports a half-dozen preset

display modes, including Scenery, Racing, Cinema, RTS/RPG, FPS, and sRGB.

Blue light filters come standard on many modern monitors and the PG27AQ is no different; there are 5 low blue light levels you can choose from. The LED-lit stand also lets you adjust the screen for your comfort, with support for height (120mm total), tilt (-5 degrees and + 20 degrees), swivel (-60 degrees, +60 degrees), and rotate (90 degrees, for portrait or landscape viewing modes) adjustments. If the highly adjustable stand doesn't do it for you, the monitor also supports a VESA-compatible mounts.

On top of everything else, this monitor also comes with a pair of 2-watt stereo speakers, a pair of USB 3.0 ports, a USB 3.0 upstream port (the requisite cable), and even a 3.5mm headphone jack.

It's true you'll need some serious graphics horsepower to fully appreciate this monitor, and deep pockets to boot, but if you've got it (courtesy of NVIDIA) and them, then consider the ASUS ROG Swift PG27AQ, as it is one of the best-looking UHD monitors you can buy. ■

BY ANDREW LEIBMAN

Specs: 27-inch 4K (3,840 x 2,160); 16:9 Aspect Ratio; Pixel Pitch: 0.155mm; Brightness: 300cd/m²; 1.07 billion colors (10-bit); 4ms Response Time (GTG); 6mm bezel; tilt, swivel, pivot, and height-adjustable stand; Ports: DisplayPort 1.2, HDMI 1.4, 2x USB 3.0, 3.5mm jack audio; 2x 2-watt stereo speakers

HEAVY GEAR

2.0 OUT OF 5

CPU



ETS-N31

\$19.99

ENERMAX

www.enermaxusa.com

ENERMAX ETS-N31

Looking for a new CPU cooler to pair with a Ryzen processor? ENERMAX recently released the ETS-N31, an affordable (\$19.99) air cooler with a pre-installed AMD mounting bracket. The ETS-N31 is also designed to maximize system compatibility, thanks to a compact, slim design that should fit into most any chassis and not interfere with a motherboard's DIMM slots. The ETS-N31 is compatible with modern Intel processors, as well, and features a tool-free mounting system.

If you've owned or seen an ENERMAX air cooler in the past, you're likely familiar with the host of cooling enhancements the company adds. The ETS-N31, despite its compact design, comes with ENERMAX's big three: HDT (Heat-pipe Direct Touch), VEF (Vacuum Effect), and VGF (Vortex Generator Flow). VEF and VGF are two technologies that help to increase air convection and airflow around the heatsink's three 6mm heatpipes. When combined with the included 92mm fan, ENERMAX rates the ETS-N31 with a 130W TDP cooling capacity.

The 92mm fan supports a PWM range from 800 to 2,000rpm. At the lowest speed, ENERMAX rates it for 13.12cfm

and a static pressure of 0.86mmH20. Ramping the fan up to 2,000rpm brings airflow up to 32.8cfm and static pressure to 2.15mmH20. Maximum noise level from the cooler, according to ENERMAX, is 24.5dB(A). The fan features a clip-on design that's simple to snap on and off the heatsink.

The ETS-N31 is one of the easiest to install air coolers we've tested. Where others include several mounting brackets and a universal backplate with multiple sets of holes, ENERMAX goes with a setup that's more like a stock cooler. The pre-installed AMD mounting bracket, for example, is a metal rocking clip that hooks onto the motherboard's plastic retention bracket. Securing the ETS-N31 to an Intel socket also utilizes the pre-installed AMD clip, but you must first attach the included plastic Intel mounting bracket to your motherboard. For a tool-less design, the Intel mounting bracket is secured by plastic push-pins.

Less-advanced builders, or people who've never installed a CPU cooler, should appreciate the simple installation process. That being said, some power users might prefer a more solid mounting mechanism—one that doesn't rely on plastic retention

brackets—to help ensure even pressure. Still, many coolers in the ETS N31's \$19.99 price range also rely on plastic backplates, mounts, and/or retention brackets.

To test out the ENERMAX ETS-N31, we installed it onto an AORUS GA-Z270X-Gaming 7 with Intel's Core i7-7700K. Idle temps, on average, were 32.3 degrees Celsius—a fine starting point for an air cooler. Temperatures were less impressive under load. Average temperatures after running POV-Ray 3.7 for 10 minutes brought the Intel Core i7-7700K up to 87.5 C with a maximum temperature of 90 C. Prime95 is an even more demanding test, and here, the Intel Core i7-7700K occasionally throttled down with temperatures reaching 99 C, and average temperatures were 96.6 C.

We don't expect a compact, affordable CPU cooler to keep up with power user duties, so the high temperatures under load weren't too surprising. Still, ENERMAX offers other compact coolers, such as the ETS-T50 AXE, that are quite capable. Ease of installation and superb compatibility are the ETS-N31's best calling cards, making it an option for beginners. ■

BY NATHAN LAKE

Specs: Materials: Copper (base, 6mm heatpipes), aluminum (fins); Fan: 92mm PWM (800 - 2,000rpm); Cooler Dimensions: 4.9 x 3.7 x 3.1 inches; Socket compatibility: Intel LGA 775/115X/1366, AMD AM4/AM3(+)/AM2(+)/FM2(+)/FM1; Warranty: 1 year

Test System Specs: CPU: Intel Core i7-7700K; Motherboard: AORUS GA-Z270X-Gaming 7; GPU: GIGABYTE GeForce GTX 1080 Xtreme Gaming; Memory: Corsair Vengeance LED 16GB DDR4-3200MHz; Storage: 480GB Patriot Hellfire; OS: Windows 10 Enterprise

CPU RANKING 0 = ABSOLUTELY WORTHLESS 2.5 = ABSOLUTELY AVERAGE 5 = ABSOLUTELY PERFECT



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MSI Radeon RX 570 GAMING X 4G

We just got a hold of the MSI Radeon RX 570 GAMING X 4G, a sub \$200 card that performs a lot like the stock-clocked RX 480 from last year. Under the hood, you'll find the same 14nm FinFET Gen 4 GCN (Graphics Core Next) architecture-based GPU, now named Polaris 20, which measures 232mm². Astute readers will notice that this die size is the same as on the RX 580, and that's because it's essentially the same GPU, only with four fewer CUs enabled (there are 32 total). As a result, there are 2,048 stream processors, 128 texture units, and 32 ROPs. This card features 4GB of 7Gbps GDDR5 installed on the PCB, however, we're told that there will be some RX 570s with 8GB of memory. The memory bus is 256-bits wide and the card is capable of up to 224GBps of memory bandwidth. AMD's RX 570 reference design calls for base and boost clocks of 1,168MHz and 1,244MHz, respectively. MSI's substantial cooler and custom seven-phase VRM-based PCB give the GPU a lot more space to run wild, however, so the OC Mode clock (enabled via the MSI Gaming App) can boost the core to up to 1,293MHz and the memory clock to up to 7,100MHz.

All of MSI's GAMING X series graphics cards look roughly the same. But the RX 570 is a 150-watt card, so it doesn't make sense to install the same heatsink that MSI uses for the GeForce GTX 1080 or even the RX 580. On this slightly slimmed down version of the Twin Frozr VI you'll find one 8mm and one 6mm heatpipe that converge over a copper plate on top

of the GPU's heatspreader, and both the heatpipes and copper plate sport a nickel-plated finish. There's no backplate or PCB face plate like on MSI's higher-powered cards, but the same red and black heatsink shroud with red LED highlights is here and an RGB MSI dragon logo adds some extra visual appeal. The aforementioned Gaming App lets you tweak the LED behavior, and for those who want to push the clocks higher, MSI's Afterburner software is one of the best Windows-based overclocking utilities we've used.

The large 95mm TORX 2.0 fans on this card feature two types of blades, with matte-textured traditional blades connected low on the hub alternating with bulging blades with a glossy stripe mounted higher on the hub. These "dispersion blades" accelerate airflow without increasing noise output, for 22% more air pressure than fans with traditional blades. MSI's ZeroFrozr technology keeps the fans motionless until the GPU is under load.

Power comes to the card via a single 8-pin PCIe power port and display outputs on the back bracket include two HDMI, two DP, and one DVI port.

If you're looking to max out the settings on all of your games at 1080p, the MSI Radeon RX 570 GAMING X 4G will more than get you there. The 4GB frame buffer is too small for reliable 1440p gaming, though less demanding games will look great at this resolution. ■

BY ANDREW LEIBMAN

Radeon RX 570 GAMING X 4G

\$175
MSI
us.msi.com

Specs & Scores	MSI RX 570 GAMING X 4G
Boost clock	1,293MHz (OC)
Memory clock	1,775MHz (OC)
Memory interface	256-bit
Memory	4GB GDDR5
3DMark Fire Strike Ex.	5,304
Graphics Score	5,443
Physics Score	20,605
Games	(1,920 x 1,080)
Shadow Of Mordor (Vsync Off, Ultra, DoF, OIT, Tess.)	83.4fps
Metro: Last Light (DX11, V High, 16XAF, V High Tess.)	78.33fps
Dying Light (High, AO On, AA On, Vsync Off)	91.91fps
Witcher 3: Wild Hunt (Vsync off, Unl. fps, Ultra)	62.02fps
	(2,560 x 1,440)
Shadow Of Mordor (Vsync Off, Ultra, DoF, OIT, Tess.)	60.01fps
Metro: Last Light (DX11, V High, 16XAF, V High Tess.)	50.33fps
Dying Light (High, AO On, AA On, Vsync Off)	65.17fps
Witcher 3: Wild Hunt (Vsync off, Unl. fps, Ultra)	45.04fps
	(3,840 x 2,160)
Shadow Of Mordor (Vsync Off, Ultra, DoF, OIT, Tess.)	32.99fps
Metro: Last Light (DX11, V High, 16XAF, V High Tess.)	25.33fps
Dying Light (High, AO On, AA On, Vsync Off)	33.85fps
Witcher 3: Wild Hunt (Vsync off, Unl. fps, Ultra)	25.45fps

Test System Specs: Processor: Intel Core i7-6950X; Motherboard: GIGABYTE GA-X99-Ultra Gaming; Memory: 16GB HyperX Predator DDR4-3000; Storage: 240GB OCZ Vertex 3 MAX IOPS SSD; OS: Windows 10 Enterprise

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RIG OF THE MONTH

AVADirect Z270 Scorpio

First showcased at CES 2017 in GIGABYTE's Caesars Palace suite, AVADirect's Z270 Scorpio celebrates the color scheme of the GIGABYTE's AORUS brand with orange accents that draw the eye and pop against the piano-black paint on Thermaltake's Core P5. The open-air chassis is an excellent choice, as it offers perfect visibility for the

high-end modifications, including the orange coolant running through the hardline tubing loop and the orange GPU backplates. The additions are more than just aesthetic, as AVADirect installs a 480mm radiator and overclocks the Intel Core i7-7700K (5GHz) and the dual NVIDIA GeForce GTX 1080 Founders Edition cards.



The orange GPU backplates mesh nicely with orange liquid coolant and stand out against the Z270 Scorpio's primarily black backdrop.



HEAVY GEAR

4.5 OUT OF 5

CPU

Z270 Scorpio

\$8,000 (as tested)

AVADirect

www.avadirect.com

Hardcore Hardline

AVADirect does a good job of using all of the Core P5's considerable space. For example, the long 480mm radiator fills up the right side of the case, while the AORUS GA-Z270X-Gaming 7 and GTX 1080 Founders Edition cards anchor the left side. The hardline tubing loop runs throughout the system and brings everything together visually. AVADirect made a few interesting bends with the PETG hardline tubing, opting to loop many of the bends rather than making conventional 90-degree turns. We particularly like the loops in the short runs; they are more attractive than a slight curve or angled fitting.

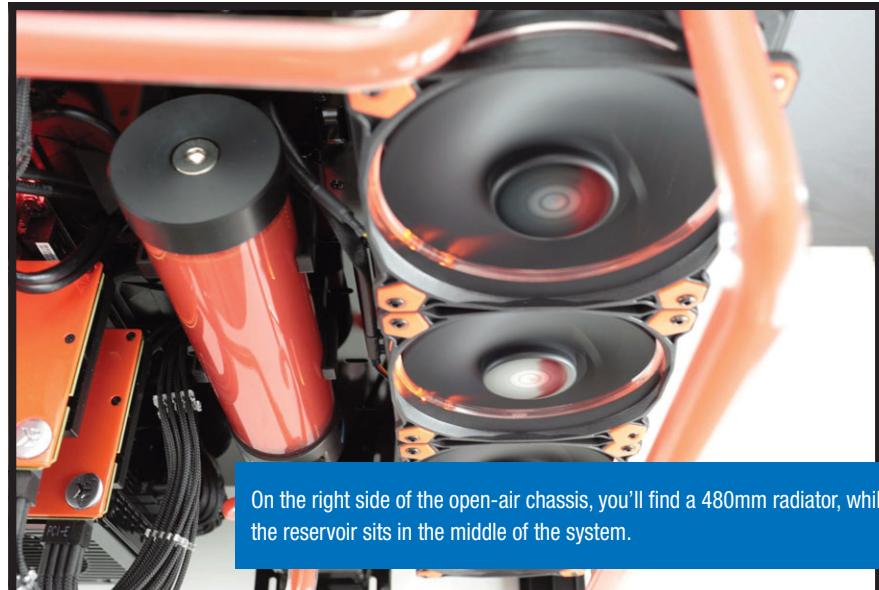
The twists and turns of the Z270 Scorpio hardline tubing are complimented by orange LEDs throughout the system. The AORUS GA-Z270X-Gaming 7 illuminates much of the left side with LEDs at the edge of the PCB, as well as under the slots and heatsinks. The onboard lighting nicely sets off the motherboard and GPUs from the chassis. The clear CPU waterblock also features orange LEDs that light up the AVADirect logo. On the right side, the 480mm radiator is cooled by four Thermaltake Riing 12 LED Orange fans.

Way More Powerful Than Project Scorpio

A build that looks this nice deserves high-end hardware to match. To reach 5GHz on the Intel Core i7-7700K, AVADirect made small changes to the BCLK and CPU voltage, so you know the builder didn't just pump up the multiplier. The dual NVIDIA GeForce GTX 1080 Founders Edition cards also boast a swift 1,898MHz Boost Clock, a big jump from the stock 1,733MHz Boost Clock speed. To maintain optimal SLI speed, AVADirect also installs GIGABYTE's high-bandwidth SLI bridge. The Z270 Scorpio's cooling system had no problem with the extra CPU and GPU power.

AVADirect fills out the system with a 32GB of G.Skill Trident Z DDR4-3466 (two 16GB modules), a 500GB Samsung 960 EVO, and a Corsair AX1200i power supply. On the latter, the builder adds the same piano-black paint job as the Thermaltake Core P5 case, as well as black individually sleeved cables. Cable combs are liberally applied to the cables to keep the wiring neat. AVADirect also optimized the 500GB Samsung 960 EVO's performance with some tweaks to the BIOS and bus speeds.

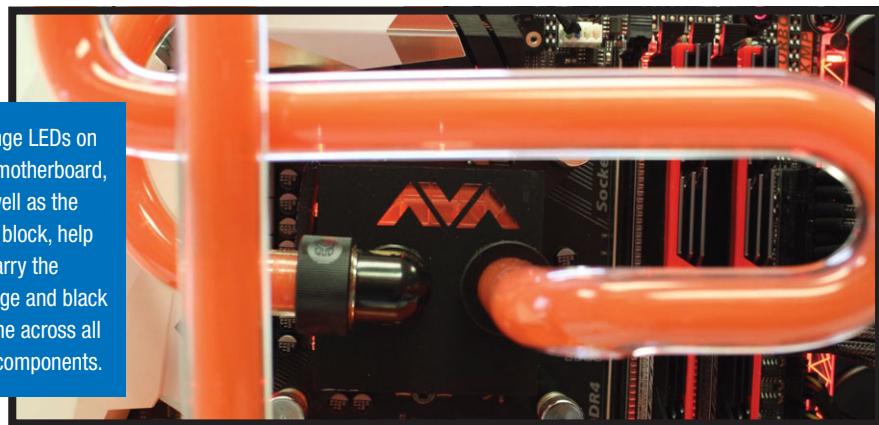
The AORUS GA-Z270X-Gaming 7 is a solid base for this configuration of high-end hardware, and it offers some flexibility for upgrades down the road. For example, you could build upon the single Samsung 960 EVO with two more PCIe, NVMe SSDs in RAID 0. Such a



On the right side of the open-air chassis, you'll find a 480mm radiator, while the reservoir sits in the middle of the system.



Orange LEDs on the motherboard, as well as the CPU block, help to carry the orange and black theme across all the components.





The system features several loops in the hardline tubing and these are a creative way to avoid using standard curved bends or angled fittings.

configuration could include a second M.2 drive and a U.2 drive, for example. We also like that the GA-Z270X-Gaming 7 includes Creative's Sound Core 3D audio processor, a Thunderbolt 3 port, and eight hybrid fan/pump headers.

A Stealthy Scorpio

Fan noise is a common issue people have with open-frame chassis, but the Z270 Scorpio build is surprisingly quiet—it stays nearly silent under most loads. The EKWB pump was only audible during boot, and fan noise from the Thermaltake Riing 12 LED Orange fans was non-existent, except when we ran games at 4K resolution. Even then, system noise under 100% load was comparable to the idle noise level of air-cooled hardware in a conventional case.

Orange Crush

The Z270 Scorpio's aggressive overclocks and the BIOS tweaks—which would be available to any customer who selects AVADirect's overclocking service—ensure the system would put the hurt on our benchmark tests.

Specs:

Processor: Intel Core i7-7700K @ 5GHz; Motherboard: AORUS GA-Z270X-Gaming 7; GPU: NVIDIA GeForce GTX 1080 Founders Edition (x2 SLI); RAM: 32GB G.SKILL Trident Z DDR4-3466; Storage: 500GB Samsung 960 EVO; PSU: Corsair AX1200i; OS: Windows 10 Pro 64-bit; Warranty: 3 years

3DMark's Fire Strike Extreme is an excellent example of the system's optimization with the incredible Graphics score of 20701 pushing the Overall score to 17238. We performed our game tests on the Z270 Scorpio at both 2,560 x 1,400 and 3,840 x 2,160 resolutions. At the former, frame rates were well above 100fps, highlighted by 168fps in Dying Light. Bumping up to 4K resolution wasn't much more of a test for the rig, as Dying Light still ran at 100fps.

There was no letdown in any of our benchmark tests. Random 4K reads and writes in CrystalDiskMark, for example, were above 800MBps. Sequential read/writes reached 3,167MBps and 1,710MBps, respectively. The CPU-intensive Cinebench 15 (1087 points) and POV-Ray 3.7 (2,364.6 pixels per second) scores are much higher than the scores we see with a stock-clocked Intel Core i7-7700K. The Scorpio's system memory is fast, too, with 39GBps in SiSoftware Sandra's Memory Bandwidth test.

Your Enthusiast Horoscope

The AVADirect rigs we've seen are routinely big, bold, and beautiful, and the Z270 Scorpio delivers much of the same, in terms of attention to detail and creativity. There's beast in this beauty, as well, with exceptional overclocks and performance optimizations that power users should appreciate. And although we know that not everyone can afford an \$8,000 build, AVADirect's overclocking service is available on many of the boutique builder's more affordable systems, should you wish to take advantage of the significant performance bump. ■

BY NATHAN LAKE

Benchmark Results	Z270 Scorpio
3DMark Fire Strike Extreme	
Overall Score	17238
Graphics Score	20701
Physics Score	15651
PCMark 8	
Creative Score	6716
SiSoftware Sandra 2017	
Dhrystone AVX2 (GIPS)	231.49
Whetstone AVX (GFLOPS)	136.23
Multi-media Integer AVX2 x32 (Mpixels/s)	654.62
Multi-media Long-int AVX2 x16 (Mpixels/s)	236.71
Multi-media Quad-ALU x1 (Mpixels/s)	2.66
Floating B/F AVX/128 (GBps, mem bandwidth)	39
CrystalDiskMark 5.12 (MBps)	
Sequential Read (Q32T1)	3167
Sequential Write (Q32T1)	1710
Random 4K Read (Q32T1)	858.9
Random 4K Write (Q32T1)	801.6
POV-Ray 3.7 (Pixels/s)	2,364.6
Cinebench 15 (Points)	1087
Games	2,560 x 1,440
Metro: Last Light (Very High, 16xAF; SSAA off)	147fps
Dying Light (High, AO On, AA On, Vsync Off)	168fps
Witcher 3: Wild Hunt (Vsync Off, Unl. FPS, Ultra)	111fps
Games	3,840 x 2,160
Metro: Last Light (Very High, 16xAF; SSAA off)	88fps
Dying Light (High, AO On, AA On, Vsync Off)	100fps
Witcher 3: Wild Hunt (Vsync Off, Unl. FPS, Ultra)	75fps

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www.booksmania.net

SkyVue

This month's Mad Reader Mod comes to us by way of Jeffrey Stephenson, the beginning of whose PC-building career more or less epitomizes the old saying "necessity is the mother of invention."

"I started 'modding' back in 2002 after VIA released the very first Mini-ITX motherboard, and there were few available cases for it," Stephenson says. "I discovered that a desktop cigar humidor was the perfect size and proceeded to mount a computer inside of one. VIA invited me to display my creation at CES 2003, and things kinda took off from there."

Stephenson, a retired 62-year-old living in rural Florida, says he does all of his modding either on the dining room table or on a folding card table set up on his deck. He says he put in a considerable amount of time on SkyVue: "Around 200 hours over a nine-week period."

His inspiration for the build is fairly obvious; SkyVue is an art deco skyscraper. "I find retro designs that I like and try to translate that style into a PC enclosure," Stephenson explains. "The cover is veneered in Sapele, an African variety of Mahogany. SkyVue has an aluminum frame that has aircraft-grade birch plywood fused to it. The three decorative stripes are polished aluminum bar stock."

A Solid Foundation

Stephenson, who was an engineer in the U.S. Navy, has more than a passing familiarity with equipment cooling. Not surprisingly, it was a cooling system that led to the creation of SkyVue.

"I was intrigued by Corsair's new low-profile watercooler, the H5 SF," Stephenson says. "So I decided to do something that would highlight it in a build. At the same time, I had a SilverStone LC-02 HTPC case that was all-aluminum but, more importantly, it had the risers and extensions necessary to mount a video card in a 'laid down' position. The idea for the art deco skyscraper cover came only after the assembled internal component structure looked like a tall, stepped building. I had a 3-year-old art deco lamp design that meshed nearly perfectly with the physical requirements of the cover."

In addition to the H5 SF, SkyVue contains an Intel Core i5-6600K processor, a GIGABYTE GA-Z170N Mini-ITX motherboard, a 16GB Corsair Vengeance LPX DDR4 kit, a GIGABYTE GeForce GTX 1070 Mini ITX graphics card, a Corsair SF600 SFX power supply, a Kingston HyperX Predator 240GB M.2 SSD, and a Corsair Neutron XT 480GB SSD.

A Clean Slate

SkyVue isn't a brand-new mod; Stephenson submitted it as a Mad Reader Mod entry nearly a year ago, but sometimes it takes us a while to find a spot for some of the great projects that show up in our inbox. In the meantime, Stephenson completed another mod, which he calls Clean Slate.

"I finished it in December 2016," he says. "Recently I've made a few cosmetic changes and am currently reshooting the photography for the Cooler Master Case Mod World Series 2017."

You heard the man; keep an eye out for it! ■





We Want Your Mod

Have a PC mod that will bring tears to our eyes? Email photos and a description to madreadermod@cpumag.com. If we choose your system as our "Mad Reader Mod," you'll win \$1,500!. (U.S. residents only, please.)



Drop Us A Line Today!

PAX East 2017

The Best & Brightest Of Boston's Big Gaming Show

Outside the halls of PAX East, Boston was a cold and snowy affair, complete with icicles adorning the Boston Convention & Exhibition Center. Freezing temperatures and icy conditions might have made travel difficult, but attendees were rewarded with access to plenty of new games, high-end PC hardware, and awesome geekery. At the center of the show floor, Intel showcased the seven finalists competing in the 2017 Extreme Rig Challenge. Designed and constructed by boutique system builders, all of these rigs feature a 7th Generation Intel Core processor and Intel SSD 600p Series SSD. Other than these requirements, the system builders were free to select the rest of system components.

Intel Extreme Rig Challenge 2017



NCIX PC won last year's competition, and the builder is back with a lot of colorful customizations.

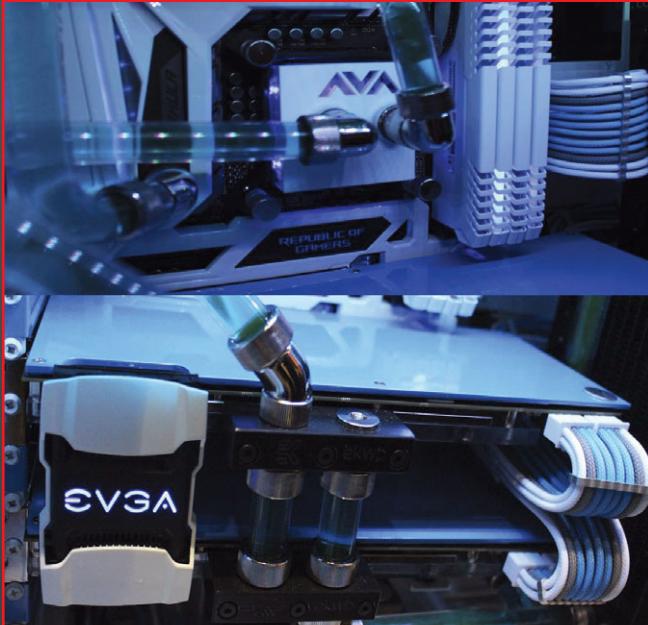


Origin PC's system includes two PCs, both capable of powering a VR system, and an LCD display/window on each side.



CyberPowerPC (left) takes this In Win chassis to another level. Meanwhile, XIDAX (right) equips this PC with lots of RGB fans, so it could really be any color, but the blue-and-white theme seen here is an excellent match for the custom parts.





There are hardly any parts that AVADirect didn't customize on inside and outside of this build. The level of detail is exceptional.



Maingear chose to go in a subtle direction with this build, with just enough lighting to offer a glimpse of its interior components.

Gems Of The Expo Floor



GIGABYTE showed off a prototype AORUS external graphics box that boasts plug-and-play connectivity via Thunderbolt 3.

Alphacool and ModMyMods displayed a clear CPU waterblock that will be part of Alphacool's Eisblock lineup.

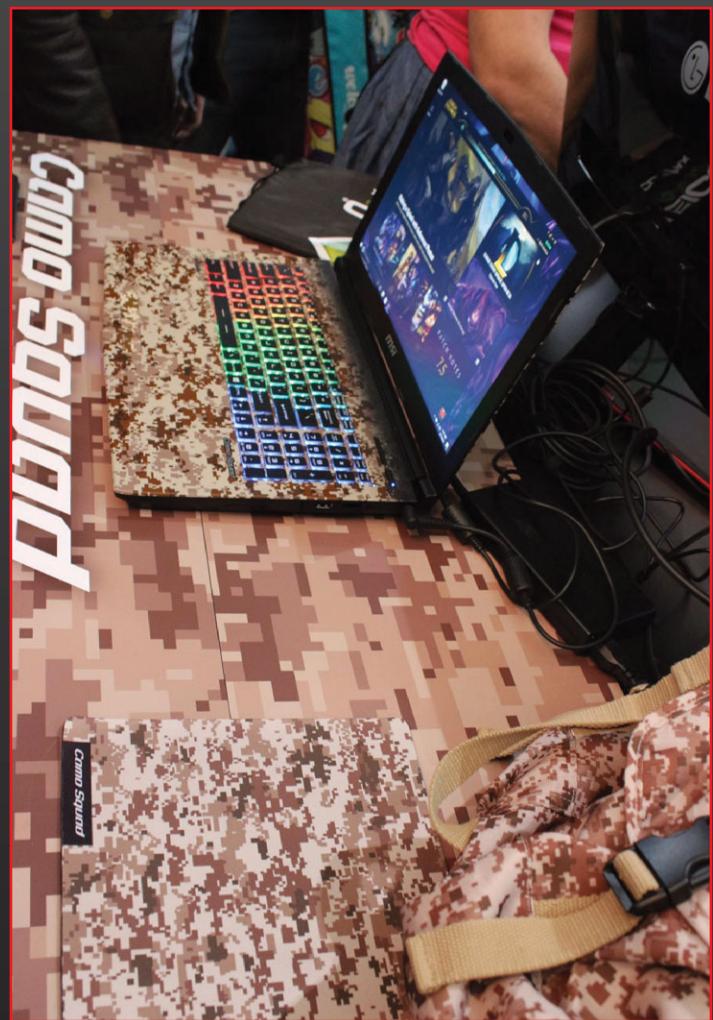




DXRacer's booth hosted some excellent gaming competitions, as well as some of the most comfortable seats on the show floor.



Bill Owen's Rogue One mod was based on Corsair's Carbide Series Clear 600C.



MSI's new Camo Squad hardware includes laptops, motherboards, and GPUs adorned with desert camo designs.

Cosplay In The Cold



Soldier: 76 (Commando 76 skin) and Roadhog weren't deterred by the cold weather.



At PAX, even the Ghostbusters took a few minutes to play some videogames.



Earl, of
Toejam &
Earl: Back In
The Groove,
was at the
Adult Swim
Games
booth.



D.Va and Soldier: 76 (Classic skin) were also roaming the show floor. Overwatch was clearly a cosplay favorite this year.

LANFest Springs Into Action

LANFest NETWAR 32.0 & Gamers For Giving 2017

Ever have one of those weekends when there's just way to much stuff going on to do all the things you want to do? The first weekend of April was kinda like that, with top-shelf LAN parties taking place in Omaha, Nebraska (LANFest NETWAR 32.0) and at Eastern Michigan University in Ypsilanti, Michigan (Gamers For Giving 2017). *CPU* was lucky enough to be in attendance at both events, so we thought we'd share a little of the fun we had with you.

NETWAR 32.0

NETWAR kicked off at 7:00 p.m. on Friday, March 31 at The Mark, an amusement center in Omaha, Nebraska, and ran straight through until 10:00 p.m. the following night (April 1). In just 27 hours, the LAN party hosted tournaments in League of Legends, Counter-Strike: Global Offensive, Rocket League, and Overwatch, and offered free-play periods for Unreal Tournament, CS:GO, and Heroes of the Storm. Travis and company also held their usual massive door prize raffle on Saturday afternoon, we judged a mod contest, and there were several vendors at the LAN showing off their products and services, as well.

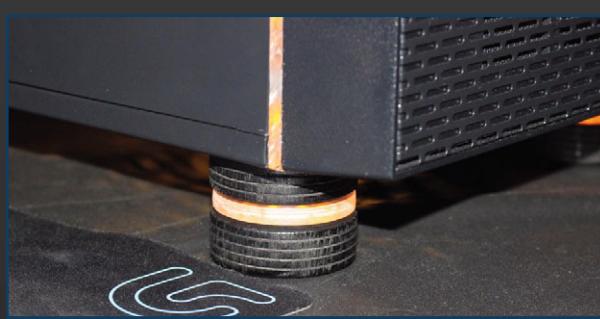


The intrepid NETWAR staff prepares the venue for the madness to come . . .



NETWAR 32.0 was a landmark event for the Omaha LANFest chapter, as it was the first NETWAR event ever to surpass the 500 attendee mark! The NETWAR staff were well prepared, though, and the venue was more than up to the task of containing so much gaming energy for the event's 27-hour duration. In addition to the courts where the LAN party was held, The Mark contains bowling lanes, a laser tag facility, an arcade, and more.

The winning mod in our contest was by Joshua Judy, who modified one of Thermaltake's Core small form factor cube cases so that it can accommodate standard ATX motherboards. To do this, he had to build his own custom motherboard tray and literally turn the case upside down, which in turn forced him to rotate the front panel logo and relocate the case feet. Speaking of the feet, he built his own custom feet that include backlit acrylic inserts, an extension of the translucent acrylic accent he added between the front panel and the case body. Add to that his hardline cooling system and hand-sleeved cables, and you have a great-looking case that is thoroughly re-engineered to do what Judy wants it to.



Dave Cathey was also at NETWAR, and his Twelve-80 scratch build (right) was a close runner-up. He built the main structure of the case (including both sides) out of a single sheet of aluminum, added another piece for the case's bottom and back panels, did a ton of custom work on his components, and added the cool vinyl logos you see here and there. Cathey's projects are always great, and this one was no exception!

Gamers For Giving 2017

We've covered Gamers for Giving events in the past, but here's a quick refresher: Gamers for Giving is a LAN event hosted by the Gamers Outreach Foundation, a charitable organization that raises funds to put videogame carts in hospitals for kids. This year's event, held at Eastern Michigan University's Convocation Center, a several-thousand-seat sports arena and event center, raised \$315,069 for the GO Kart program. The event hosted more than 1,200 attendees on-site, and its live-stream broadcast was viewed by more than 240,000 unique visitors, who could also donate via the web.

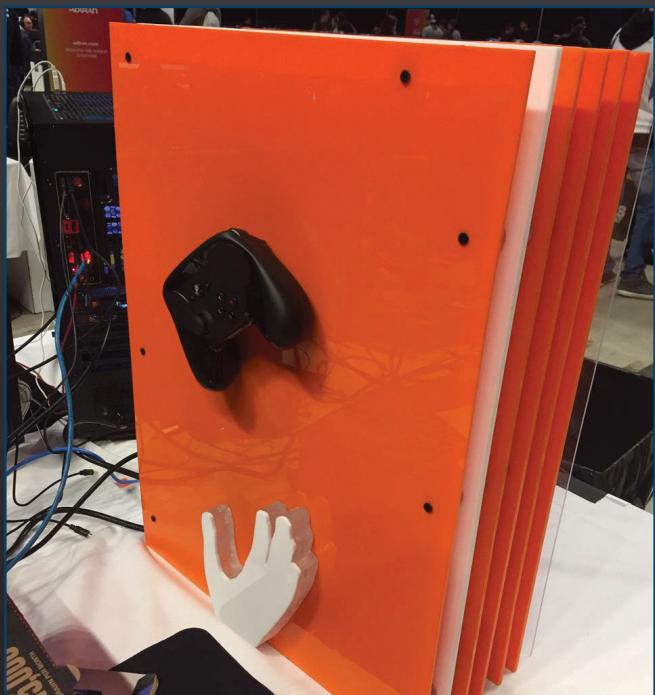


There was, of course, a lot of gaming throughout the two-day event, which started at 9:00 a.m. on Saturday, April 1 and ran through 11:00 p.m. on Sunday, April 2; tournaments included Halo 5, Call of Duty: Modern Warfare Remastered, Super Smash Bros. Melee, Clash Royale, Call of Duty: Infinite Warfare, Overwatch, League of Legends, Counter-Strike: Global Offensive, Hearthstone, Rocket League, and StarCraft 2. There were lots of cool AFK contests and activities, as well, including a *CPU Case Mod* Contest.



Zach Wigal, founder of the Gamers Outreach Foundation.

The winner of our mod contest was Joel Dekker, whose custom oak scratch build is one of the nicest wooden cases we've seen in a long time. The woodworking alone is impressive, but as you can see through this rig's enormous side panel window, the system inside is pretty well-made, too. Dekker's custom cooling loop and sleeved cables give the inside a clean, powerful look that nicely complements its exterior.



You've probably seen this before in our coverage of Gamers for Giving events, but in case you wondered: Mad Reader Mod alumnus James Fislar built this stunning Gamers for Giving PC with help from NVIDIA, Intel, HyperX, EVGA, and EKWB.

YOU LAN

How To Host Your Own LAN Party

Since the existence of “2P,” videogames have had a social element. Yes, there are plenty of great titles for when you want to be a hermetic gamer and go it alone, but so many epic and unforgettable moments happen in multiplayer. *GoldenEye* was golden when you and three friends fought against each other to be the last man standing. *World of Warcraft* wows the most when you down a new raid boss with your guild or reach the top of the Arena ladder with your team. *CS:GO* only goes when your 5 goes head-to-head with another 5.

The overwhelming majority of multiplayer gameplay, whether that's PvP or co-op,

happens online, and it's been that way for nearly two decades. Of course, the presence of the almighty internet makes gaming with friends and strangers alike a trivial matter, but it misses out on all the other fun that only happens when gamers get together IRL. In our humble opinion, there's no better place to gather and game than a LAN party.

Maybe you love attending LAN parties as much as we do. Maybe, between *Overwatch* matches and swigs of energy drinks, you think, “I could do this. I *should* do this.” Maybe you feel like the best LAN party ever is going to be the one that you organize. Maybe you're right.

Here's a definite: You haven't done anything yet. Buying a seat at a LAN party and winning a pepperoni-pizza-eating contest is one thing. Negotiating with a venue to host your event, enticing enough people to attend, setting up a network, and actually running the show—it all adds up to countless unpaid hours for a brand-new LAN party that could have rows of empty seats. You don't want that to happen. We don't want that to happen.

After hosting CPULAN last year, we learned firsthand how much work goes into organizing and hosting a LAN party. We have plenty of advice to pass on to



One day, your LAN party may host hundreds of gamers who hail from every corner of the country. That day is not today. For your first LAN party, keep your expectations in check if you want to make it to your second LAN party. Creating a small, memorable event is a much better recipe for success than trying to hold a massive LAN party and having it bomb.

aspiring admins, but don't take our word for it; we called on a few friends to offer their insights, as well.

Our Panel Of Experts

A good LAN party doesn't happen without a great organizer or two. Our admins have learned from experience what works and what doesn't, and they want to pass that experience on to you.

Husband and wife team Harold and Ruxandra Bratcher are proof that you don't have to know everything about launching a LAN party as long as you team up with others who know the rest. The duo coordinates SAN LAN (www.sanlan.org), a huge event in San Antonio, Tex.; Harold deals with the technical aspects of SAN LAN, while Ruxandra handles press and marketing. According to Harold, "Our goal is to institute the largest and most exciting tournaments in the South Texas area."

Nick Engstrom says that KCGameOn (kcgameon.com) started like a lot of successful LANs start. Originally, the LAN party began as a team-building event for a dozen co-workers. KCGameOn kept growing, and now it hosts over 500 attendees and 25 tournaments every two months. Engstrom has his eye on December, when he says he aims to host a multi-day event for 1,000 attendees.

Shane Baker helms eDrenaline eSports (www.edrenaline.net), which is bringing a big tournament to the Cleveland area this August. He's preparing to host 16 amateur teams to do battle in Overwatch and Heroes of the Storm, respectively.

Finally the University of Wisconsin-Stout's PONG (People's Organization of Network Gaming; pong.uwstout.edu) makes LAN party organization a true team effort. Connor Glade, Pierce Lannue, Dan Murray, and Kayla Frohmader each weighed in on questions related to their area of expertise.

Party Planning

Tempting as it might be to attempt the next QuakeCon or DreamHack, your LAN party will be much more successful if you start with more modest ambitions. It's better to keep your first event small and grow it organically than commit to the world's first 490-empty-seat LAN party.



Everyone loves freebies, especially free hardware, and that can be a tricky issue for fledgling LAN parties. If you approach sponsors honestly, keep your request reasonable, and follow through on promoting them at your event, you'll build a relationship that could eventually lead to the good stuff.

Our admins differed slightly on an exact attendance goal for your first LAN party, but none of them recommended exceeding 25 attendees. Engstrom says first-time organizers should set a target even lower.

"I always recommend that people concentrate on starting in the five- to 10-person range," he says. "Start with a group of friends that can provide you feedback, that won't be angry that things are not working right away. The first few LANs are always a learning process, as you will eventually be adding more switches, DHCP servers, and game servers in the future."

Baker and Bratcher agree that even rookie LAN party organizers should be able to pull off a 25-person gathering. This size will keep logistics such as power, internet, and staffing all manageable and any unforeseen issues relatively easy to contain. By limiting your attendance, you can focus on delivering a LAN party people will want to return to . . . with their friends. "It's better to focus on quality vs. quantity throughout all stages of organizing a LAN party," says Harold Bratcher. "A limited number of attendees gives your LAN a chance to be a quality

event catered for a small number of people that will spread the word."

Once you determine how many gamers you'll be inviting to your soirée, you have to find a place to put them all. You don't need a tutorial to explain where to host that 10-man LAN Engstrom suggests: Your home will work perfectly for a very small party. When attendees are fighting for elbow room in your one-car garage, though, you'd better find a bigger space.

Small, first-time LAN parties should have plenty of available options, which will let you find a venue within your budget. College students have university facilities at their disposal, and grown-ups with an exceptionally cool boss (or an irreplaceable position at their company) might be able to get away with using their place of employment for their LAN party. Unsurprisingly, several LANFest events occur on Intel's campuses, for example. If you deal with venues that will rent you "Conference Room B," you'll have the benefit of discussing your event with someone who knows exactly whether her venue can accommodate your LAN party.

A little creativity could score you a nice deal, though. We've heard of small LAN parties convening at a Denny's restaurant.

Rather than fixate on the physical space for your event, our organizers stress finding a place capable of meeting the unique needs of a LAN party, namely power, internet, and HVAC.

"Heating and cooling of the LAN area is something that may not be obvious at first, but it can really affect how much people enjoy the event," Glade explains. "With so many consoles, PCs, and people generating heat, it won't take long for the event space to get too hot if it's not being handled properly."

Engstrom agrees. "Air conditioning is really easy to overlook. One of the easiest way to drive away players is to make them uncomfortable for hours at a time."

Baker says that a venue's internet speed has become even more important as games increasingly connect to third-party servers rather than support LAN play. "Most LAN parties today actually rely on the internet, because so many popular games don't have the ability to run a local server." We also recommend understanding ahead of time what a venue charges its customers for bandwidth consumption. The last thing you want is to be stuck with an outrageous bill because half of your attendees were streaming Netflix in 4K rather than gaming.

Finally, do your homework on a venue's electrical infrastructure, because we'd wager there aren't many gatherings that are more power-hungry than a LAN party with dozens of gaming PCs and networking equipment. Our admins agree that a good rule of thumb to follow is to budget four or five PCs for every 20-amp circuit. Engstrom and Glade both say that developing a circuit map helps prevent power-related headaches on the day of your LAN party.

"Talk to the building manager about electricity," Glade says. "Plan how many power strips and extension cords to get and what length. PONG has a number of power diagrams that show exactly where to plug in extension cords, and where on the tables the power strips go."

"We use a circuit finder to map and label all of the circuits we use for each LAN," Engstrom adds. "This allows us to

use simple math to figure out how many computers can be used on a single circuit."

Engstrom also recommends thoroughly investigating and understanding what a venue intends to charge you for using its space. "There are several hidden costs that you need to watch for: table/chair rental, power cords, truck rental to haul the gear, clean-up fees, tear-down fees, up-front deposits, and venue insurance are just some of the things we have run into."

Party Promotion

Usually, finding a venue to hold your LAN party is the easy part, as plenty of places will gladly take your money to use their facilities. Convincing strangers to pay *you* money to attend your LAN party—that's another matter entirely. Let's start by disabusing you of any fanciful notions that "professional LAN party planner" will become your new full-time job title. Sure, you might put in full-time hours leading up to your event, but you won't make a dime doing it. If you have to buy networking equipment or other hardware, look at your LAN party as a long-term investment (which makes having a successful first event doubly important.)

"If you're considering organizing LAN parties for profit, forget it," Ruxandra Bratcher says. "You have to be able to invest quite a bit in your passion. SAN LAN's comeback event in August 2016 had a cost of approximately \$7,500. This cost went down about 20% to 25% for the next events, as we didn't have to buy anymore equipment."

Using social media to reach your target market shouldn't come as a big surprise, as all of the organizers we talked to utilize Facebook for their LAN parties. With a little social networking savvy, though, you can find potential attendees outside your circle of friends.

"Start by using a Twitter crawler to find all profiles that say 'games' or 'gaming' in a 50 mile radius from your venue location," Engstrom recommends. "Follow all of these people and make sure you drop some information about your LAN in your tweet history."

Although traditional methods of advertising such as television and radio tend to have both the most limited reach

and the highest cost, don't be afraid to do some analog advertising, particularly if you live in an area with a high density of potential attendees (hint: like a major university). "I do not think social media is a waste of time in any sense, but there are many other resources that can be used with it," Frohmader says. "For example, our LAN information is displayed at least a week ahead of time on posters across our campus and at local shops surrounding campus."

The allure of prizes and swag is a big draw, of course, but stockpiling an appreciable amount of phat lewt isn't something you should finance out of your pocket. Ideally, you want sponsors to shower you with giveaway goodies. First-time LAN party organizers may struggle to prove their event's worth to manufacturers that have limited supplies they can dole out to all the other LAN parties clamoring for the same hardware, but that shouldn't deter you from establishing partnerships now that could turn into serious hardware as your event grows over time.

"Pay attention to social media and see which companies seem to embrace the LAN party scene," Baker recommends, "then just think of yourself as a salesman do your best to 'sell' your LAN party to them. What do you have to offer in return for their sponsorship?"

Murray says that communication with sponsors after your event is just as important after your event as it is before. "Make sure you keep the sponsors updated and let them know that their donations/help wasn't wasted. Send pictures of the event and the sponsor's product, tell them what forms of exposure you brought to their company, and just let them know their product went to a good cause."

Although most organizers approach hardware companies with sponsorship requests because of the tangible rewards they can deliver, remember that other sponsors can also provide benefits to your event. Local restaurants could cut you and your attendees a deal on food, and energy drink brewers typically send their beverages for quenching thirst and fueling all-night gameathons. (A word of advice:

Be sure to discuss food and drink with potential vendors, even those that don't have on-premises food service, ahead of time.) Sometimes, sponsors will aid a LAN party with cold, hard cash.

"SAN LAN got lucky and received a financial sponsorship from StreamMe, which provided us with \$2,000 [as prize money] for the winning teams," Ruxandra Bratcher says. "We are really grateful to have such an important eSports production and streaming company helping our event grow."

Networking Know-How

Obviously, setting up a LAN party's network is a much different animal than connecting your three home PCs to a media server. It's a dense topic, and one that could fill an article or two by itself, but we'll cover some of the basics.

If your networking experience is limited, recruiting a knowledgeable friend is invaluable, but there are other ways to learn the ins and outs. Engstrom recommends tapping into the Reddit hive mind. "A great place for reference and interaction is [reddit.com/r/lanparty](https://www.reddit.com/r/lanparty). These folks will typically answer your networking questions, as well."

You can also gain "on-the-job" experience by volunteering at another LAN party. As long as you don't plan to schedule your own LAN party on the heels of theirs and/or poach attendees, you'll find that the local scene isn't a zero-sum game. Most established admins will bestow their knowledge upon LAN party padawans.

A home router and a couple of switches might allow you to host a small LAN without adding a big expense to your bottom line, but once your event grows large enough to earn a "medium-sized" designation, expect to start acquiring more robust networking hardware. As an example, Harold Bratcher lays out SAN LAN's setup.

"For our network we have a pfSense SG-2440 firewall, a Cisco Systems SG-200-18 for our core switch, and Cisco SG-200-8 switches for our tables. Each player plugs into the table switch. From there they are routed back to the core switch and then out to the internet through the

firewall to connect to Steam or Battle.net. For servers we have two 1U rackmount 16 Intel Xeons with 256GB of RAM and 8TB of storage. Those boxes run several TeamSpeak, CS:GO, and Steam caching servers for our events."

On the software side, pfSense is one of the most popular tools for LAN party admins, and for good reason. As free, open-source software, it won't add anything to your LAN party's bottom line, and there is ample documentation available online for you to learn its ins and outs.

"It is the easiest, yet most versatile routing software to utilize," Lannue says. "It fulfills all of our needs in one package: routing, load balancing, DHCP, firewall, DNS, and other logging services. Once it is set up, it is easy to maintain."

Prepare For Liftoff

As soon as you know how many gamers you want to attend your LAN party, where your attendees will convene, how you plan to convince them to attend, and what you're going to use to connect them together, you'll have covered most of the

basics. That said, there's nothing basic about your first LAN party, even if you're not planning a blockbuster.

Although we recommend giving your event some structure, usually in the form of tournaments, you should avoid overwhelming your attendees with a schedule that feels more like weekend National Guard drills. Set up a poll on your LAN party's website (yes, you're going to need one) so you'll know what games your attendees actually want to play, and space out tournaments with the expectation every single one of them will last longer than intended.

Your LAN party might be your idea, but it shouldn't be a solo project; it's time to call in those favors you've banked with your buddies over the years. Line up a few friends to serve as event staff, and be sure to get enough recruits to ensure that no one works a 48-hour shift.

Finally, as much work as hosting your own LAN party is, don't lose sight of the fun. Keep your event focused on giving your attendees every opportunity to have a great time, and they'll be back for more. ■



Believe it or not, your attendees might not want to spend every second of your LAN party glued to their systems. By offering a diverse selection of activities, such as tabletop and/or console gaming, and fun contests, you'll give partygoers other things to do and more reasons to come back for your next LAN party.

Modder Q&A: Heath Coop

Another PDXLAN Alum, Another Award-Winning Modder

We bumped into Heath “TekLord” Coop as we have with so many excellent modders, at PDXLAN in Portland, Oregon. Coop won our mod contest, and has participated in a number of prestigious events. In addition, Coop is the founder and owner of Tek by Design, a computer modding, design, and fabrication company.

Q: Your work has appeared in our monthly “Mad Reader Mod” feature once (our October 2014 issue), and you participated in the 24 Hours of LeMods event at QuakeCon in 2016. What other contests and modding events have you been a part of?

HC: I’ve competed in Cooler Master’s Case Mod World Series and GIGABYTE’s Mod2Win contest previously. I’ve also competed in some smaller “Mod of the Month”-type events and done well. The *CPU* Magazine PDXLAN mod contest has always been my favorite.

Q: You won the 24 Hours of LeMods in 2016, right? Can you tell us about that event, and about your DOOM mod, built with Jim Weist?

HC: Yes, we did win the 24 Hours of LeMods at Quakecon 2016. The basic idea of the event is to give three teams of two modders each identical hardware and give them three consecutive eight-hour days to build the best mod they can.

Jim and I agreed that we wanted to do something that we hadn’t seen before in a contest like this, so we decided on doing electroplating live at the event. We combined that with a faux-rust-painting technique that I really think brought out the atmosphere that you feel when playing Doom.



Coop in 2014 posing with his PDXLAN-winning mod, Demon Speeding.

Q: How did you and Jim get paired up for that event? Did you know him before, and how did the partnership work out?

HC: I honestly am not sure how Jim and I became a team. I’m not sure if he picked me, I picked him, we picked each other, or we ended a team by default.

We’ve known each other for a few years now. We were both brought in by a mutual friend to help administrate an

online group and we became fast friends. Up until the day of the event, we had never met in person. Despite that, we clicked instantly. It always seemed like we were on the same page. He was really a pleasure to work with. I hope we get the opportunity to work together again.

Q: You mentioned GIGABYTE’s Mod2Win event: How’d that turn out?

HC: I really enjoyed the event. I knew several of the competitors



This unassuming appliance may look like an old-timey radio, but it's actually Crosley, another excellent Coop mod.

and it was fun just to see all their work. Unfortunately, I became sick towards the end of the event and wasn't able to finish my 2099 build in time.

Q : Did you ever get a chance to finish 2099? It looked like it was going to be pretty cool!

HC : I had to put 2099 on the back burner shortly after the contest ended, as I was preparing to move. Once the move was over, I found the box containing several key components for the build was missing. I was completely heartbroken. Luckily, a manufacturer has stepped forward to assist me in replacing those parts.

Not all is bad, though. The delay has actually worked out well from a design standpoint, as I wasn't quite happy with the design I had come up for the exterior. The limited time I had to build with during Gigabyte's Mod2Win contest meant I needed to make the exterior simpler than I originally planned for. Now I can go back and make the exterior design mesh better with the interior.

to make my PC run cooler. It didn't take me long to break out my Dremel and drill to make the modifications to install more fans, and these soon turned into lighted fans and neon.

Q : It's probably not hard to get inspired to mod when you attend a modding-rich event like PDXLAN in Portland. Was there anyone in particular whose work really motivated you to try your own mods?

HC : Bill Owen of Mnptech was probably the greatest influence in bringing me back to modding. I had stepped back from PC building for about three years. I decided to do a build again and came across one of Bill's videos while doing research on cases. It was all over then, I jumped in with both feet.

Ron Lee Christianson has also been a huge influence. His Resident Evil mod just blew my mind. It drastically expanded my ideas of what a mod could be. Ron and I have since become friends. I've had the opportunity to work with him, as well. He continues to inspire me more than anyone else.

Q : How many PDXLAN events have you attended now?



Coop's Ms. Purple mod.



A look at both sides of DOOM, a mod created by Coop and Jim Weist at the 24 Hours of LeMod event at QuakeCon in 2016. Coop and Weist completed the mod in three eight-hour days for the contest, and their mod won the day.

HC : I've been attending since PDXLAN 21. PDXLAN 29 was my eighth.

Q : What is your specialty as a modder, or what part of a mod project do you think most plays to your strengths?

HC : I've owned a Dremel rotary tool since 1993, well before I started modding computers. I have thousands of hours using it. I can do just about anything I want with it. If something needs to be cut, drilled,

ground, or polished, I'm your guy. No case is safe from my Dremel.

Q : If you could outsource one step in every mod project, which one would it be, and why?

HC : That would definitely be the paint. I'm a competent painter in my own right, but it's often easier to outsource it. Let the professionals deal with the sanding dust and cleaning the spray guns.

Q : How long have you been offering custom PC services through Tek by Design, and what kinds of services do you provide?

HC : Tek by Design will turn four years old this year. Over that time the selection of available services has expanded greatly. Originally, I offered mostly design consultation and system builds. Now Tek by Design has its own brand of stainless steel fasteners and metal finishing services. The latest service that has been added is electroplating.

Q : It's time once again for Five Quick Questions!

1) Intel or AMD?

Intel.

2) Pre-paint sanding or cable sleeving?

Pre-paint sanding.

3) Best shop music: Metal or classical?

Metal.

4) Big Mac or the Whopper?

Whopper!

5) "Alien" or "Aliens"?

Aliens. ■

Can We Bend It?

Alphacool Custom Hardline Cooling Tutorial, Part II

Last month, we touched on why an enthusiast might want to install a custom hardline liquid cooling setup in her rig, listed the requisite liquid-cooling parts, enumerated the handful of items that vary between flexible and hardline cooling loops, stressed the importance of making sure all components share the same threading and fitting sizes, and even covered some of the advantages of using PETG over acrylic tubes, but stopped short of actually delving into the particulars of bending. If you'd like a refresher on any of last month's topics, we encourage you to read that article first.

In this article, we'll talk about the tools available that can make cutting and bending a significantly less stressful endeavor, cover some strategies for finding your ideal bending technique, and help you avoid making the (many, many) mistakes we made. Let's get bending.

Part I, Addendum

Last month, we recommended using olive oil to lubricate the silicone insert when bending PETG or acrylic tubes. After we went to press, our Alphacool representative Eddy Peters suggested dish soap as an alternative, and we can verify that it works just as well as the olive oil, but is easier to clean out afterward. Regardless of the type of lubricant you use, you'll need to thoroughly wash out the tubes before installing them and filling the system with coolant.

Hot Topic

Working with a heat gun requires a clear work space, a decent pair of gloves that will insulate your hands and fingers from the hot pipe and the heat gun's nozzle, and a healthy dose of plain old caution. At full temp, a heat gun can melt plastic and ignite combustible materials. Even after it has been turned off, the heat gun's nozzle will remain very hot for several minutes, so be careful.



There are lots of tools you can buy to help make identical bends every time, but they require practice to master.

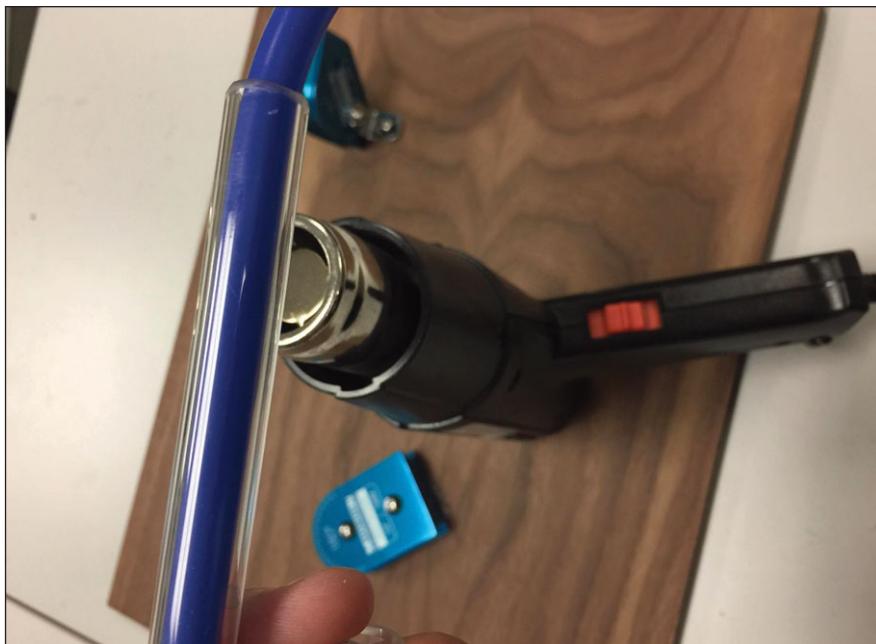
The fundamental key to bending tubing is applying just the right amount of heat to ensure the plastic tube is pliable enough to be molded into a shape that lets it line up with the ports on your radiator, blocks, reservoir, and pump. Too much heat, and the plastic tubing can actually begin to boil, adding unsightly bubbles to the plastic. Overheated tubing can also warp and lose its shape, despite the use of a silicone insert, rendering the pipe unusable. If you attempt to bend before the plastic is hot enough, you can force the plastic to buckle, fold, or flatten.

Heat guns come in many varieties, with different wattages and settings, which will affect how quickly you get to a bendable pipe. The environment in which you're working and even the chemical properties of the PETG or acrylic pipe you're using can also have a big impact on your bending experience, which is why there's no magic formula for finding and maintaining that ideal bending temperature.

Trail & Error

At first, we tried using the high setting on our 1500-watt heat gun, reasoning that we would be able to get decent bends as long as we kept the pipe six or more inches away from the nozzle of the heat gun. Although this was a sound strategy in theory (and one that may work for you), it took significantly longer than we were hoping for the pipe to get soft, and when our patience wore thin and we brought the pipe closer, we found ourselves going from rigid and unbendable to boiling plastic in the blink of an eye.

Strategies that helped us included lowering the temperature (our heat gun has high and low settings) and bringing the pipe to within two to three inches of the heat gun's nozzle. Rotating the pipe and moving it back and forth over the nozzle will gradually bring the pipe to bending temperature and help you determine, based on when the pipe begins to get floppy, how much heat is enough.



Determining the ideal heat gun setting, nozzle distance, and heating time are key to consistently making quality bends.



There's a lot that can and will go wrong as you begin to make your first bends.

It's also important to heat up a portion of the pipe that's slightly larger than the portion that'll need to bend. A 90-degree bend, for example, may require you to bend two to three inches of the tubing. The middle of that 90-degree bend will need

to be the softest, but if there's not enough softened tube on either side, the pipe will bend at a sharper angle and potentially buckle. Take the time to familiarize yourself with the process and your tools by making some practice bends at various angles.

Those bent tubes also make great reference pieces for making your final measurements. For instance, the 180-degree mandrel from our Monsoon Hardline Pro kit creates two-inch-long bends. Keep in mind that you want to measure from the center of the hole, either of the pipe or the fitting, to the center of the opposite hole to get proper distances. Once you know how much length it takes to create your various bends, you can factor those in when using a ruler to note the distances between the various fittings. It's also important to measure from the inside base of the fitting, not the opening edge.

Another strategy we learned to rely on was to make our bends as close to the middle of the 80cm tubes as possible, which gave us plenty of excess to cut off when it came time to trim the pipes to fit between the components' fittings. As we mentioned last month, we used the Alphacool pitsaw for trimming our pipe, but a ratcheting PVC cutter would be a fine substitute because it creates clean cuts that don't require a reamer or deburring tool to smooth out. The old adage "measure twice, cut once" applies . . . to an extent. When trimming the bent pipe to fit into your system, err on the side of having the pipe be ever so slightly too long, and don't be afraid to make two or three cuts to the ends of the pipe to get it to fit. It's much easier to deburr the pipe ends each time you trim off a fraction of an inch than it is to have to scrap the pipe and start again because you accidentally trimmed off too much.

Bending Tools

As we mentioned last month, some experienced system builders prefer to bend by hand. Although it can take a substantial amount of practice to get good at it, making your bends by hand is beneficial because you can typically tell how much a tube will bend before it begins to buckle or warp. Alternatively, when bending with a mandrel kit like the Monsoon Hardline Pro or the Alphacool Double Bending Tool,

you're less likely to see the inside curve of the tube until it has cooled, and by then it's usually too late to finesse it into the shape you want by applying a little more heat.

On the flipside, using one or more bending tools is a good way to create consistent bends, which is important when you're constructing a symmetrical hardline tubing system. Even when using tools, however, we found that there are usually one or two areas that'll require a little hand bending.

We had a lot of success with Monsoon Hardline Pro Mandrel Kit. We used the included set of brackets to mount the 90- and 180-degree mandrels to a flat board, and this provided us with a stable platform for making most of our bends. We used the 360-degree mandrel for some hand bending that was required to make the double loop-the-loop at the base of our pump and reservoir. The Alphacool Acrylic Double Bending Tool was also handy for making bends to pipe that already had one or more bends in it, and it works just fine with PETG.

We should also point out that you don't need to restrict yourself to using tools created specifically for hardline bending; for a handful of very sharp bends we needed to create, we used the shaft of a permanent marker in place of a mandrel. You can use almost any rounded, solid object to aid in the bending process, as long as it's sturdy and you can get a good grip on it.

Cooldown

After bending the pipe around a mandrel or the household object of your choice, it generally takes about 30 seconds for the pipe to become cool



The end result isn't even close to what we see from *CPU*'s Mad Reader Mods, but it's a start.

enough to hold its shape. You can also use a small fan to decrease the time it takes to get the bend to solidify. Before the pipe is cool, try to avoid touching or applying pressure to the softened portion of the pipe, as it can dent or mar the surface of the tube.

The Big Cheat

There's a shortcut to making a good-looking hardline tubing system, and it's one we see even professional modders employ all the time. It involves getting a series of angled fittings, spacers, and adapters and connecting them in a series to eliminate the need for making an additional bend right at the waterblock, reservoir, pump, or radiator. We used four 90-degree adapters on the radiator, and it simplified connecting the pipes to the next component in our loop, even though our measurements were slightly off. It's true, replacing tube bends with adapters and spacers will cost you a

fair bit of extra money, but it'll also eliminate some serious frustration. Some hardline bending purists may see this strategy as a cop out, but the end result still looks stunning.

One of the most important pieces of advice we can impart is to make sure every fitting, spacer, and adapter is screwed in tightly. In the case of the hardline fittings we used, which employ O-rings, it's important to only finger-tighten the components. Using a wrench or pliers can strip threads of soft metals like aluminum and copper, and of plastics like acetyl.

Try, Try Again

Even though we struggled—and failed—repeatedly, anyone who wants to take his system to the next level should absolutely consider installing a custom hardline liquid-cooling system. As long as you have enough pipe, you can always start from scratch. Making a stunning loop takes time, so be patient. And most of all, be creative! ■

When AORUS Met Ryzen

GIGABYTE's GA-AX370-Gaming K7 Is AM4 Done Right

As far as seismic events that shake the PC industry go, AMD's debut of its long-awaited Ryzen processors had to have registered at least an 8.0 on the Richter scale. After playing second fiddle to Intel's chips for years, we finally have another series of very powerful and very affordable CPUs that look capable of challenging for the throne. Typical of AMD's high-end offerings, every Ryzen has an unlocked multiplier, giving power users almost free reign to tinker with the CPUs, extracting even greater performance from Ryzen's already formidable silicon. We covered Ryzen extensively last month, with our review of the Ryzen 7 1800X on page 22 and a four-page in-depth look at the Ryzen platform, starting on page 46.

However, every enthusiast with a modicum of experience knows that no processor can reach its true potential without a little help from an equally capable motherboard. A thorough BIOS, tough-as-nails board components, and an array of inputs and outputs do so much heavy lifting that one could make the case that an elite motherboard is every bit as crucial as the CPU itself. Ask anyone who's ever tried to coax every last megahertz out of a processor with a budget motherboard and tell us what he said.

GIGABYTE wants Ryzen owners to push their new processors without fear or hesitation. When designing the GA-AX370-Gaming K7, the company wanted its AM4 flagship to have every weapon possible at its disposal.

"When we first began getting specs for Ryzen, we were excited but cautiously skeptical," says Matthew Hurwitz, GIGABYTE technical marketing manager. "Roadmaps and data sheets are great, but until you have a product in hand to test, you learn to curb your expectations.

Around January, we started getting reports from our engineers showing Ryzen had the potential to make a big splash. At that point we only had early engineering samples but the hype began to build. Fast-forward to the launch of Ryzen 7, and it was clear AMD delivered.

"The [GA-AX370-Gaming K7] is our flagship AM4 motherboard, and we, like our customers, wanted it all. We started out with all the features and software that have become staples in our motherboard lineup such as RGB Fusion, Smart Fan 5, System Information Viewer, Dual Hybrid Fan headers, etc., but we knew we had to do more."

Zen State Of Mind

As AMD marched toward Ryzen's inevitable release, its partners, including GIGABYTE, followed closely behind. Although the company has been developing motherboards for decades, AMD's Zen microarchitecture required GIGABYTE to build an elite board around a brand-new platform.

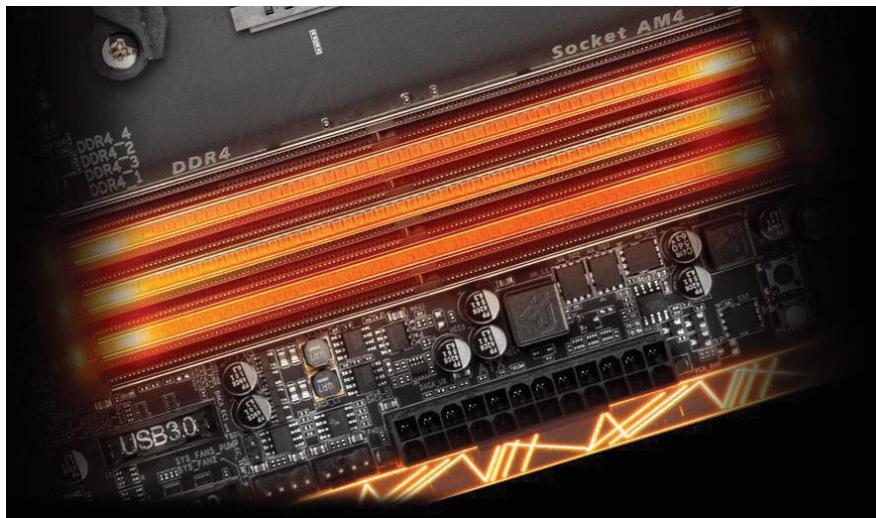
Hurwitz explains GIGABYTE's design process for the GA-AX370-Gaming K7. "There are two important factors to keep in mind with a new platform: function and implementation. Function-wise, AMD has stepped up its feature set to include

things like native USB 3.1 Gen. 2 support. Users looking to upgrade to the AM4 platform should feel secure knowing they are buying a platform with a modern feature set to support the current hardware landscape and beyond."

The dawn of the Ryzen Era wasn't completely free of snags. Shortly after launch, AMD and motherboard makers had to contend with system memory support quirks that affected the range of speeds that worked with Ryzen-compatible motherboards. Hurwitz says



AMD made a splash when it released its Ryzen CPUs to the masses, and GIGABYTE was ready with the GA-AX370-Gaming K7. Armed with features like Turbo B-Clock, this AORUS motherboard should give power users the ability to squeeze every last drop of performance out of the new processors.



We have seen the light, literally. With the Age of LEDs upon us, the GA-AX370-Gaming K7 lets users put on a serious light show. Strategically placed LEDs (such as between the board's DIMM slots, above) and serious software are proof of the resources GIGABYTE has devoted to making the LED experience top-notch.

that GIGABYTE has been huddling with AMD and DRAM manufacturers to address XMP compatibility on the GA-AX370-Gaming K7 and other related

GIGABYTE boards; he indicates that a BIOS update is on the horizon, but daring power users can visit GIGABYTE's forums to acquire a beta BIOS.

Cocked, Locked & Ready To Overclock

Befitting its role as the flagship of GIGABYTE's X370 motherboards, the GA-AX370-Gaming K7 has virtually every bell and whistle in the company storeroom. It has sights to see and is cool for coolers. We'll explore those in short order, but in order to really tap into Ryzen's potential, GIGABYTE equipped this motherboard with components designed for overclocking and performance tuning.

One of the key ingredients is GIGABYTE's Turbo B-Clock, a specialized IC engineered to—you guessed it—give power users greater control over their BCLK frequency. Using Turbo-Clock, the GA-AX370-Gaming K7 opens up a 100MHz to 300MHz frequency range, essential for maximizing CPU and memory clocks.

"Turbo B-Clock lets users squeeze every megahertz out of their CPU and memory," Hurwitz says. "Currently the highest multiplier for memory is 36X. If you want to push your memory past 3,600MHz, Turbo B-Clock is a must."

Independent Control

Customize different colors for different sections of the motherboard.

Fully Customizable

Adjust lighting animation with color stops, color duration, transition period, and color effects

Lighting Profile

Save, export and import profiles to quickly change effects based on your preference and to share with others

Synchronize with RGB FUSION READY Peripheral

With a dazzling array of products supported, RGB Fusion is the software that brings it all together, letting your accessories synchronize to the same beat.

Enthusiasts have no shortage of options with the GA-AX370-Gaming K7's RGB Fusion software. Advanced users can dive into the desktop app to create custom colors and effects, make and share profiles, and more.

Elsewhere, the board possesses an abundance of IR (International Rectifier) components. Its 6+4-phase power delivery system consists of fourth-generation IR digital power controllers and third-gen PowIRstage ICs. The ICs also benefit from Isense, which spreads out the thermal load in order to keep individual ICs from coming under fire disproportionately.

Cue The Lights

Over the last year, LED lighting has exploded, going from a popular option for modders to a mainstay on just about every component imaginable. Most high-end motherboards have followed suit, sprinkling LEDs here and there in an effort to keep up with the competition.

The GA-AX370-Gaming K7 has plenty of LEDs, but GIGABYTE has done much more than merely load up the board and send it out to consumers. Consistent with the control the company has given power users over their components' clocks, the GA-AX370-Gaming K7 presents LED aficionados with a dazzling amount of command over LEDs both built into the board itself as well as third-party light strips connected to onboard headers. GIGABYTE collects the GA-AX370-Gaming K7's LED capabilities under the "RGB Fusion" umbrella, which consists of a mobile app and an extensive desktop client. The software has a handful of basic options for someone who wants to quickly add a little visual pop, but its true power hides in Advanced Mode. Here, RGB Fusion goes well beyond creating custom RGB colors. You can make your own effects and transitions, isolate and tweak individual LED zones on the GA-AX370-Gaming K7, and save each configuration as a custom profile.

The board's RGBW pin header opens up more possibilities. As its name suggests, it's able to address RGBW light strips (and, in conjunction with the RGB Fusion software, dynamically relocate pin "locations" for better compatibility) to produce better white light. UV-reactive light strips are also compatible with the pin header.

AORUS RISING

GIGABYTE GA-AX370-Gaming K7 Specs

Max memory	64GB DDR4 (DDR4-2667; DDR4-3600 max OC)
Slots	3 PCIe 3.0 x16*, 3 PCIe x1**
Storage	1 M.2 (2242/2260/2280/22110), 1 U.2***, 2 SATA Express, 8 6Gbps SATA
Rear I/O	1 PS/2, 1 HDMI, 1 USB Type-C, 3 USB 3.1 Gen 2 Type-A, 6 USB 3.1 Gen 1, 2 Gigabit Ethernet, 1 optical S/PDIF, audio I/O
Audio	2 Realtek ALC1220 codecs, Sound Blaster X-Fi MB5 support, HD audio, 2/4/5.1/7.1-channel surround sound, S/PDIF support
LAN	1 Rivet Networks Killer E2500, 1 Intel Gigabit Ethernet
Hardware monitoring	Voltage detection, temperature detection, fan speed detection, overheating warning, fan failure warning, fan speed control
Form factor	ATX
Warranty	3 years

*Slot labeled "PCIEX16" operates at x16 when slot labeled "PCIEX8" is empty. When both slots are populated, "PCIEX16" slot operates at x8. "PCIEX8" always runs at X8. Slot labeled "PCIEX4" always runs at x4.

**PCIe x1 slots share bandwidth with "PCIEX4" slot

***M.2 connector does not work when U.2 connector is active

Expect GIGABYTE to supplement the GA-AX370-Gaming K7's LED capabilities in the future. Hurwitz was short on details at the time of this writing, but he tells *CPU* that GIGABYTE is "working with . . . memory manufacturers to sync your motherboard, GPU, and RAM."

Chill Out

Although the GA-AX370-Gaming K7 is built to handle punishing workloads, GIGABYTE understands that the motherboard is only part of the equation. In order to give enthusiasts virtually free reign over their cooling loadout, GIGABYTE litters the motherboard with fan/pump headers and temperature sensors, then ties everything to its Smart Fan 5 utility.

"Smart Fan 5 gives users full control over their system cooling profile," Hurwitz explains. "We want our customers to be able to control and customize their system to match their usage scenario. Some users simply want plug and play. Others want to set very specific fan curves or voltages."

These aren't garden-variety headers, either. Of the GA-AX370-Gaming K7's eight cooling headers, a pair supports 24W

pumps. All of the headers have a hybrid design that lets them auto-detect what type of cooling hardware is plugged in (chassis fan, CPU fan, closed-loop liquid cooler, or standalone pump) and switch to either PWM or Voltage mode.

"Hybrid fan headers take the guesswork out of plugging in your fans," Hurwitz adds.

Ryzen Rendezvous

Obviously, there's much more to GA-AX370-Gaming K7. Familiar faces from many of GIGABYTE's other high-end motherboards make appearances on this flagship motherboard. It boasts a pair of Realtek ALC1220 codecs and Sound Blaster X-Fi MB5 support for substantial integrated audio. Its networking capabilities are geared toward gamers, thanks to Rivet Networks' Killer E2500 Ethernet controller.

The motherboard itself is built to last. Double-locking slot brackets, stainless steel shielding around the PEG and DIMM slots, and anti-sulfur resistors combine to give the GA-AX370-Gaming K7 an edge in durability. As Ryzen continues its ascent, this motherboard is a compelling launch platform. ■

Hyper Drives

Upgrade To A Next-Level SSD

Our storage has been slowing us down for decades. The fastest processor and fistfuls of high-end RAM can be stopped dead in their tracks if your system's storage bottleneck is particularly glaring. Early solid-state drives liberated us from the tyranny of sluggish HDDs, but as soon as manufacturers figured out how to optimize NAND and storage controllers we ran headlong into yet another bottleneck. Rather than hardware limitations, the 6Gbps SATA bus itself kept most SSDs from realizing their true potential.

We solved that problem, too, as the PCIe bus has all the bandwidth a solid-state drive could need. Gumstick SSDs that use the M.2 interface have flourished; we now have options galore. Budget builds, high-end gaming rigs, and everything in between—they should all have an SSD. And of course, solid-state drives continue to be an all-around awesome choice for enthusiasts seeking the best possible bang:buck ratio when upgrading their machines. We've collected 16 candidates worthy of your bucks.

Eye On Optane

Every now and then, a company zigs while the rest of the industry zags. That's a fair description of Intel's Optane drives, which take a different approach to solid-state storage. In 2015, Chipzilla whipped power users into a frenzy when it announced 3D XPoint memory, the product of a joint effort between Intel and Micron. Originally promoted as being a mouthwatering 1,000 times faster than traditional NAND, 3D XPoint SSDs looked like the next game-changing tech.

However, the first batch of Optane drives for desktop systems don't quite live up to the early hype. Initial Optane SSDs will serve as a non-bootable cache, akin to Intel's 20GB SSD 311 Series. By caching frequently used data, an Optane SSD teams up with a hard drive to yield far better results than what you'd otherwise get from a hard drive. Standard PCIe SSDs will outrace an Optane SSD cache, but enthusiasts will eventually be able to score a bootable 3D-XPoint-based drive. Our guess is that a consumer offering will look something like Intel's Optane SSD DC P4800X, but retooled for client systems rather than data centers. Like any revolutionary hardware, expect to pay a hefty early adopter tax for a consumer version of the P4800X, as the 375GB version of the drive carries a \$1,520 MSRP. If you can both afford a drive and afford to wait, these SSDs could yet deliver on Intel's 3D XPoint promises.

Intel SSD 750 Series 1.2TB

\$1,029

www.intel.com

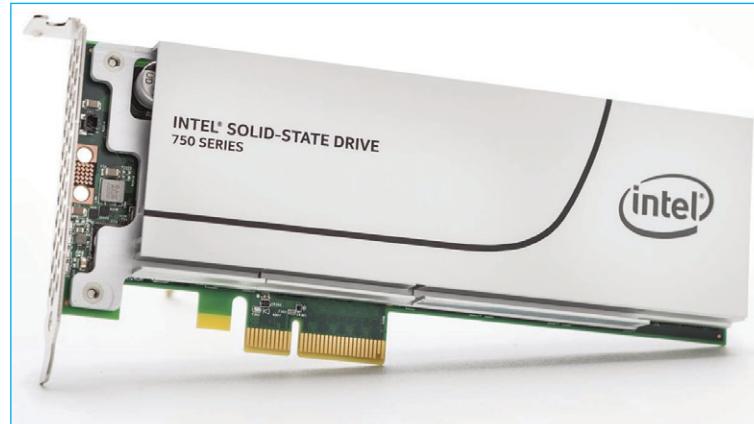
Why You'll Dig It: Forget for a moment that Intel launched the SSD 750 Series two years ago. These drives have withstood the test of time and remain one of the best options for anyone looking for a PCIe NVMe SSD. Don't let that MSRP scare you, either; we didn't have any trouble finding this drive online for less than \$850 (you might be able to score up one for even less than that), and 1.2TB is a *lot* of fiendishly fast storage. How fast? We're glad you asked. The 1.2TB SSD 750 Series drive zooms around the test track at a brisk pace of 2,400MBps for sequential reads and 1,200MBps for sequential writes. It handles random I/O pretty well, too, clocking random reads of 440,000 IOPS and random writes of 290,000 IOPS. If you have other plans for your motherboard's PCIe x16 or x4 slots, Intel has you covered, as the SSD 750 Series drives are also available in a 2.5-inch U.2 form factor. (Make sure your mobo supports U.2, naturally). As you probably expect at this point, Intel backs its flagship SSDs with a five-year warranty.

Who Should Apply: Simply put, power users who want a PCIe SSD that is very, very big and very, very fast.

Capacity: 1.2TB

Interface: PCIe x4

Bus: PCIe 3.0 NVMe



Patriot Hellfire 480GB

\$249.99

www.patriotmemory.com

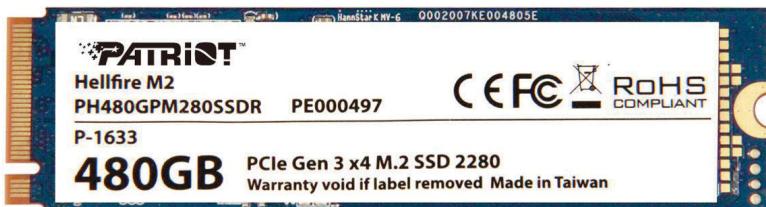
Why You'll Dig It: Patriot is one of the OGs of enthusiast SSDs, so when the company introduces its high-end PCIe NVMe SSDs, you pay attention. Along with its 240GB little brother, the 480GB Hellfire represents Patriot's current crop of PCIe SSDs. With a Phison 5007-E7 controller at its disposal, this SSD runs circles around hard drives and 6Gbps SATA SSDs. And of course, the Hellfire is also capable of hanging with other PCIe SSDs. According to Patriot's internal testing, both Hellfires soar to 3,000MBps sequential reads in ATTO; the 480GB Hellfire yields slightly better sequential write throughput—2,400MBps. In CrystalDiskMark's sequential tests, the Hellfires pump the brakes a bit, as the 480GB Hellfire turns in reads and writes of 2,550MBps and 1,260MBps, respectively. We think you'll agree that's still crazy fast. Random performance is similarly electric. When the 480GB Hellfire is firing on all cylinders, 4K random writes top out at 210,000 IOPS, and the drive can hit 170,000 IOPS for random reads. Built-in ECC (up to 120 bits per 2KB), bad block management, and static and dynamic wear leveling are additional perks you'll get from this devilishly good SSD.

Who Should Apply: Power users who want a high-end PCIe SSD from a company that knows what it's doing.

Capacity: 480GB

Interface: M.2

Bus: PCIe 3.0 NVMe



ZOTAC SONIX 480GB

\$369.99

www.zotac.com

Why You'll Dig It: As it turns out, ZOTAC has more goodies for your PCIe slots besides graphics cards. Released last year, ZOTAC's SONIX is the company's first PCIe NVMe SSD, and it's a burner. Equipped with Toshiba MLC NAND, a 512MB DRAM cache, and a Phison controller, the 480GB SONIX manages a sizzling 2,600MBps on sequential reads and 1,300MBps on sequential writes. Plus, ZOTAC wraps the SONIX in a sleek enclosure (you can't see it in the image below, but ZOTAC's logo is carved into the SONIX backplate) that's more than a pretty face. Beneath the metal, a heat spreader covers the drive's controller and its NAND, which is particularly helpful considering some PCIe SSDs have been susceptible to thermal throttling. ZOTAC covers the SONIX with a three-year warranty.

Who Should Apply: ZOTAC loyalists will no doubt find the SONIX fits right in with their ZOTAC graphics card(s), but this PCIe SSD is a solid choice for lots of builds.

Capacity: 480GB

Interface: PCIe x4

Bus: PCIe 3.0 NVMe



Plextor M8Pe(Y) 512GB

\$329

www.goplextor.com

Why You'll Dig It: Aesthetics will always take a back seat to performance, but our options shouldn't be "this" or "that." Plextor obviously got the memo, as the M8Pe(Y) is a power user's solid-state drive that also looks the part. The drive's sandblasted aluminum shell also has power and activity LEDs (white and red, respectively), so it will fit right in with that slick build you're planning. For enthusiasts who prefer the M.2 form factor, the M8Pe(G) is Plextor's gumstick take on the drive, and it features a heatsink that matches the M8Pe(Y)'s design. Of course, the M8Pe(Y) is more than a pretty face. The 512GB version featured here carved up CrystalDiskMark's sequential tests, slicing and dicing its way to 2,300MBps reads and 1,300MBps writes. Its random performance is just as strong. In IOMeter at a queue depth of 32, the M8Pe(Y) delivered random 4KB reads up to 260,000 IOPS and random 4KB writes up to 250,000 IOPS. Plextor also punished the M8Pe(Y) for two days of sustained read and write testing, 1,008 hours of error testing, and 250 power cycles. In other words, you can feel pretty good about that five-year warranty.

Who Should Apply: Power users who want their high-end PCIe SSD to have a little visual flair.

Capacity: 512GB

Interface: PCIe x4

Bus: PCIe 3.0 NVMe



Corsair Force Series LE 960GB

\$314.99

www.corsair.com

Why You'll Dig It: Let us let you in on a little secret: Although PCIe SSDs grab all the headlines, 6Gbps SATA SSDs are still plenty fast, and now they're more affordable than ever. Corsair's Force Series LE 960GB is a can't-miss option for anyone looking for almost a terabyte of solid-state storage on the cheap. As it does with its Force Series MP SSDs, Corsair turns to Phison (specifically, the PS3110-S10) for the Force Series LE's storage controller. For any drive with room to store a bunch of data, keeping said data safe and sound is extremely important. Corsair got the memo. Technologies like SmartECC and SmartRefresh are designed to ward off data-destroying errors that can occur within NAND cells, while tried-and-true wear-leveling and garbage collection techniques keep this SSD in tip-top shape over the course of its life span.

Who Should Apply: Builders who want fast access to tons of programs, games, and other data.

Capacity: 960GB

Interface: SATA

Bus: 6Gbps SATA



ADATA XPG SX8000 512GB

\$319.99

www.xpg.com

Why You'll Dig It: If ever there was an ADATA SSD that lived up to the company's XPG (Xtreme Performance Gear) label, it's the XPG SX8000. ADATA released its XPG SX8000 PCIe NVMe SSDs into the wild last fall, and they've been a strong option ever since. Under the hood, so to speak, you'll find a Silicon Motion SM2260 storage controller and 3D MLC NAND, and this SSD knows a few additional tricks, as well. By using intelligent SLC caching, ADATA reserves a portion of the XPG SX8000's NAND to act like SLC, boosting read/write throughput for frequently accessed data; a built-in DRAM cache buffer can also increase performance. At a queue depth of 32, this drive can read data sequentially at a smokin' 2,500MBps. Sequential writes are well beyond anything a 6Gbps SATA SSD can hope for, too, with the XPG SX8000 reaching 1,100MBps at full speed. It deals with 4KB random data at up to 140,000 IOPS and 150,000 IOPS for reads and writes, respectively. As proof these drives are built to last, ADATA backs the whole family with a five-year warranty. Look around online, and you can probably find the 512GB XPG SX8000 for under 250 bucks.

Who Should Apply: Gamers and enthusiasts looking to give their system a solid-state shot of adrenaline.

Capacity: 512GB

Interface: M.2

Bus: PCIe 3.0 NVMe



Samsung 960 EVO 1TB

\$479.99

www.samsung.com/ssd

Why You'll Dig It: Although Samsung's 960 PRO series is widely regarded among power users as the best of the best, its 960 EVO drives are pretty amazing for being the company's "mainstream" SSDs. As you might know, Samsung likes to keep R&D under its own roof, so the 960 EVO's Polaris controller and V-NAND are both homegrown. The combination works, as the 1TB 960 EVO has hustle to spare: 3,200MBps sequential reads and 1,900MBps sequential writes aren't too far removed from the 960 PRO drives' 3,500MBps and 2,100MBps sequential performance. At a queue depth of 1 and a single thread, the 1TB reads random 4KB data at 14,000 IOPS and writes it at 50,000 IOPS, but when you feed it with four simultaneous threads at a queue depth of 32, random performance skyrockets to 380,000 IOPS (read) and 360,000 IOPS (write). Samsung also produces 256GB and 512GB variants.

Who Should Apply: Gamers interested in getting top-tier performance while saving a little cash they can put toward a better graphics card.

Capacity: 1TB

Interface: M.2

Bus: PCIe 3.0 NVMe



Western Digital Black PCIe 256GB

\$110.99

www.wdc.com

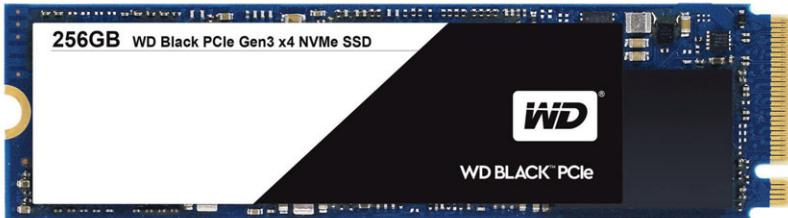
Why You'll Dig It: A household name in hard drives for years upon years, Western Digital has dabbled with solid-state drives in the past. Now, with its pair of PCIe NVMe SSDs (256GB and 512GB), WD shows that it's ready to play the great game. Both WD Black PCIe SSDs feature a Marvell 88SS1093 storage controller and batch of SanDisk 15nm TLC NAND. The 256GB WD Black PCIe SSD featured here moves at a 2,050MBps pace when it reads sequential data, and it writes sequentially at up to 700MBps. In a quad-threaded workload of random 4KB data, the drive sprints through random reads at 170,000 IOPS and 130,000 IOPS for reads and writes, respectively. (Western Digital tested at a queue depth of 32 for its sequential and random testing.) Western Digital supplements the Black SSDs with a sweet software package: WD's SSD Dashboard and Acronis True Image WD Edition. A five-year warranty is another nice perk.

Who Should Apply: Gamers and other enthusiasts who need a high-octane boot drive but don't want to pay an outrageous price at the pump.

Capacity: 256GB

Interface: M.2

Bus: PCIe 3.0 NVMe



Samsung 960 PRO 1TB

\$629.99

www.samsung.com/ssd

Why You'll Dig It: When other companies were introducing their first attempt at PCIe NVMe SSDs, Samsung was busy cranking out its second generation of high-end drives. As a result, the flagship 960 PRO series is the company's best yet, which is saying something when you consider the last-gen 950 PRO SSDs remain ridiculously good. In terms of raw power, the 1TB 960 PRO is a force of nature. Its rated sequential performance almost looks like a misprint: 3,500MBps reads and 2,100MBps writes. A quad-threaded workload of 4KB random data at a queue depth of 32 shows off the potential of Samsung's Polaris controller, too. In this scenario, the 1TB 960 PRO clocks maximum random reads of 440,000 IOPS and maximum random writes of 360,000 IOPS. Yes, you'll pay a premium for a 960 PRO, but in addition to the terrific performance the 960 PRO is built to last. Samsung covers these SSDs for five years or a mind-boggling 800TB TBW (total bytes written), whichever comes first.

Who Should Apply: If you want the best and are willing to pay for it, Samsung's 1TB 960 PRO makes a very compelling case for your cash.

Capacity: 1TB

Interface: M.2

Bus: PCIe 3.0 NVMe



Patriot Hellfire 240GB

\$129.99

www.patriotmemory.com

Why You'll Dig It: Every power user deserves a turbocharged SSD, but not every power user has the cash to sink into a big drive, which generally delivers the best performance. Riding to the rescue is Patriot's 240GB Hellfire PCIe SSD. What this drive lacks in capacity (although, let's be honest, 240GB is more than enough for your OS, a couple of games, and a few high-priority applications) it makes up for in speed. Patriot ran the Hellfire through ATTO and CrystalDiskMark to show how fast it can be, and the results are undeniably impressive. The 240GB Hellfire charged through ATTO's sequential tests, producing a maximum read of 3,000MBps and a max write of 2,300MBps. In CDM's sequential tests, this Hellfire isn't as fast, but fast (2,740MBps sequential read) is still fast (1,090MBps sequential write). You should also feel good about this Hellfire's random performance. Its 4K random read of 170,000 IOPS is just as good as the 480GB Hellfire, and a maximum random write of 185,000 IOPS is just a slight drop from the 480GB Hellfire's 210,000 IOPS.

This SSD is \$130 well spent.

Who Should Apply: This drive is the perfect answer for anyone who wants almost all of the 480GB Hellfire's performance for almost half the price.

Capacity: 240GB

Interface: M.2

Bus: PCIe 3.0 NVMe



ADATA Ultimate SU900 256GB

\$119.99

www.adata.com

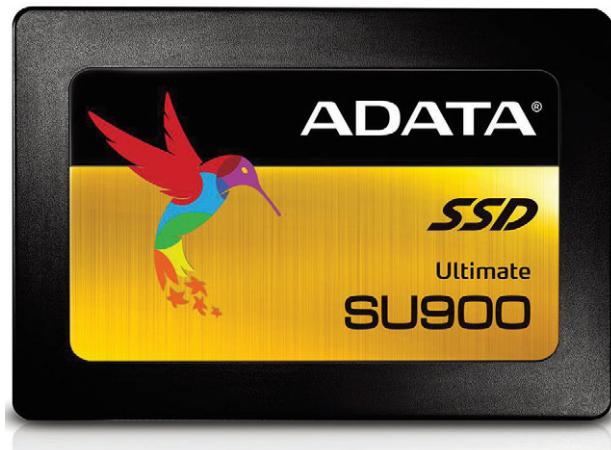
Why You'll Dig It: Remember that we said every system deserves a solid-state drive? ADATA's Ultimate SU900 is an excellent option for budget builds. We're featuring the 256GB Ultimate SU900, but the lineup also consists of 512GB and 1TB drives. (A 2TB Ultimate SU900 is in the works, too.) The SSD features a Silicon Motion controller and a complement of 3D MLC NAND. ADATA bestows the Ultimate SU900 with some of the same technological powers the company's high-end XPG SX8000 PCIe SSDs possess. Specifically, the Ultimate SU900 SSDs have intelligent SLC caching and a DRAM cache buffer, both of which should improve performance. By using LDPC (low-density parity check) ECC, ADATA manages to reduce data errors, and an extended P/E cycle should keep the Ultimate SU900 chugging when other SSDs' NAND burns out. Need proof? Look no further than the Ultimate SU900's five-year warranty.

Who Should Apply: PC builders who want an affordable, reliable SSD they can install and use with confidence.

Capacity: 256GB

Interface: SATA

Bus: 6Gbps SATA



Crucial MX300 2TB

\$549.99

www.crucial.com

Why You'll Dig It: Say it with us: Two terabytes. Yes, the big boy of Crucial's MX300 family costs a chunk of change, but break out your calculator and take a gander at that cost per GB. Spoiler alert: The 2TB MX300 costs just over a quarter a gig, making it an unbeatable value. Crucial taps Marvell's 88SS1074 to serve as the MX300's storage controller and then surrounds it with mountains of Micron (as in, Crucial's parent company) 3D TLC NAND. This preposterously big SSD also has an impressive life span. It's good for 400TB TBW (total bytes written), which translates to writing a whopping 219GB each day for five years. Plus, the MX300 holds its own against other 6Gbps SATA SSDs. It offers max sequential reads and writes of 530MBps and 510MBps. Random reads of 92,000 IOPS and random writes of 83,000 IOPS are sweet, too.

Who Should Apply: Hard drive haters ready to ditch magnetic storage for good.

Capacity: 2TB

Interface: SATA

Bus: 6Gbps SATA



Toshiba OCZ RD400 256GB

\$139.99

ocz.com

Why You'll Dig It: A super fast PCIe SSD that isn't also super expensive—why *wouldn't* you dig it? OCZ was one of the first companies to hook enthusiasts up with solid-state drives; now under the banner of Toshiba, OCZ beat a lot of other manufacturers to the punch when it jumped into the PCIe SSD market with the RD400. We also like that Toshiba and OCZ maintained tight control over the RD400, as the controller, NAND, and firmware were all developed in house. When you install this 256GB burner in your house, expect fireworks. In ATTO, the RD400 batters the sequential read and write tests, posting max speeds of 2,600MBps and 1,150MBps. At a queue depth of 32, the 256GB RD400 is actually the fastest of the bunch. In IOMeter, its peak 4KiB random read is 210,000 IOPS, and it writes random 4KiB data at up to 140,000 IOPS. OCZ also makes 128GB, 512GB, and 1TB versions of the RD400, if you need more (or less) storage.

Who Should Apply: Gamers and enthusiasts who want a freaky fast PCIe SSD that won't zero-out their bank account.

Capacity: 256GB

Interface: M.2

Details: PCIe 3.0 NVMe



SanDisk Ultra II 480GB

\$249.99

www.sandisk.com

Why You'll Dig It: SanDisk has been honing its 6Gbps SATA SSDs over the years, so the 480GB is a polished piece of kit. Whether you need to upgrade an old laptop's rundown hard drive or just want to add a little more solid-state storage to your system, the Ultra II combines terrific throughput with rock-solid reliability. Using SanDisk's nCache 2.0 technology, the 480GB Ultra II gives you performance that nearly maxes out the 6Gbps SATA bus. It delivers a maximum sequential read/write performance of 550MBps/500MBps, and it boogies through random reads and writes, too. (98,000 IOPS and 80,000 IOPS, respectively.) You can use SanDisk's SSD Dashboard to keep tabs on the drive's capacity, firmware version, and S.M.A.R.T. attributes; the software will also alert to you to firmware updates as they're available.

Who Should Apply: Builders and upgraders who need a just-works 6Gbps SATA SSD.

Capacity: 480GB

Interface: SATA

Bus: 6Gbps SATA



Corsair Force Series MP500 480GB

\$299.99

www.corsair.com

Why You'll Dig It: System memory, CPU coolers, gaming peripherals—Corsair has a knack for making hardware that rocks. The 480GB Force Series MP500 is a solid-state drive that hits you with power chord after power chord. With its Phison PS5007-E7 controller calling the shots, this SSD moves data to and fro with a sense of urgency. To give you an idea of the kind of speed we're dealing with, Corsair put a platter of benchmarks in front of the Force Series MP500. It feasted. The drive bullied ATTO's and CrystalDiskMark's sequential tests (3,000MBps/2,400MBps and 2,800MBps/1,500MBps in the respective benchmarks' read/write tests), and then it clobbered IOMeter's random 4KB tests. At a queue depth of 32, the Force Series MP500 read 4KB random data at 250,000 IOPS, and it wrote 4KB random data at 210,000 IOPS. Better yet, you can easily find an online retailer that will sell you a 480GB Force Series MP500 for almost \$50 less than its MSRP. That's a deal you don't think twice about taking.

Who Should Apply: Any power user who demands fast access to his most important apps and games.

Capacity: 480GB

Interface: M.2

Bus: PCIe 3.0 NVMe



Intel SSD 600p Series 1TB

\$359

www.intel.com

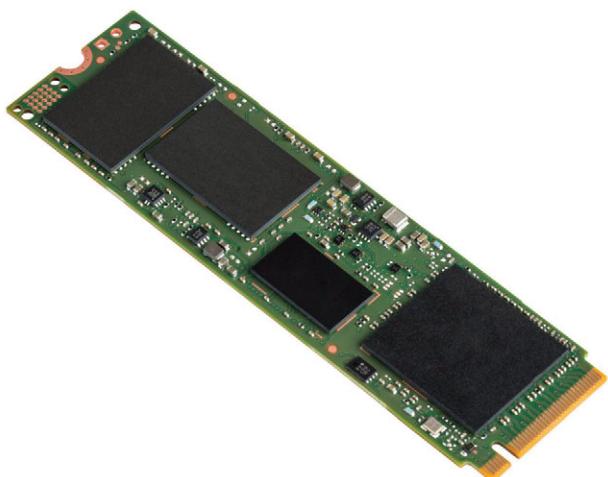
Why You'll Dig It: As far as cost per gigabyte goes, Intel's 1TB 600p Series SSD is one of the best. With so much available storage, the biggest 600p lets you install Windows and a whole lot of games before you have to worry about reaching capacity. Intel uses TLC NAND to keep costs down, but the 1TB 600p is no slouch in terms of throughput. It's capable of 1,800MBps/560MBps sequential reads/writes, and its random performance is 155,000 IOPS and 128,000 IOPS for reads and writes, respectively. And if a 1TB gumstick is a little too meaty, Intel serves the 600p in smaller portion sizes, too, namely 128GB, 256GB, and 512GB.

Who Should Apply: Savvy bargain hunters who want a big, but also affordable, PCIe SSD.

Capacity: 1TB

Interface: M.2

Bus: PCIe 3.0 NVMe



Drive	MSRP	Capacity	Advertised Sequential Read/Write	Advertised IOPS Read/Write	Data Bus	Form Factor	Warranty
Intel SSD 750 Series 1.2TB	\$1,029	1.2TB	2,400MBps/1,200MBps	440K/290K	PCIe NVMe	HHHL AIC	5 years
Samsung 960 PRO 1TB	\$629.99	1TB	3,500MBps/2,100MBps	440K/360K	PCIe NVMe	M.2	5 years
Crucial MX300 2TB	\$549.99	2TB	530MBps/510MBps	92K/83K	6Gbps SATA	2.5-inch SATA	3 years
Samsung 960 EVO 1TB	\$479.99	1TB	3,200MBps/1,900MBps	380K/360K	PCIe NVMe	M.2	3 years
ZOTAC SONIX 480GB	\$369.99	480GB	2,600MBps/1,300MBps	N/A	PCIe NVMe	M.2	3 years
Intel SSD 600p 1TB	\$359	1TB	1,800MBps/560MBps	155K/128K	PCIe NVMe	M.2	5 years
Plextor M8Pe(Y) 512GB	\$329	512GB	2,300MBps/1,300MBps	260K/250K	PCIe NVMe	HHHL AIC	5 years
ADATA XPG SX8000 512GB	\$319.99	512GB	2,500MBps/1,100MBps	140K/150K	PCIe NVMe	M.2	5 years
Corsair Force Series LE 960GB	\$306.12	960GB	560MBps/530MBps	85K/60K	6Gbps SATA	2.5-inch SATA	3 years
Corsair Force Series MP500 480GB	\$299.99	480GB	3,000MBps/2,400MBps	250K/210K	PCIe NVMe	M.2	3 years
Patriot Hellfire 480GB	\$249.99	480GB	3,000MBps/2,400MBps	170K/210K	PCIe NVMe	M.2	3 years
SanDisk Ultra II 480GB	\$249.99	480GB	550MBps/500MBps	98K/80K	6Gbps SATA	2.5-inch SATA	3 years
Toshiba OCZ RD400 256GB	\$139.99	256GB	2,600MBps/1,150MBps	210K/140K	PCIe NVMe	M.2	5 years
Patriot Hellfire 240GB	\$129.99	240GB	3,000MBps/2,300MBps	170K/185K	PCIe NVMe	M.2	3 years
ADATA SU900 256GB	\$119.99	256GB	560MBps/520MBps	N/A	6Gbps SATA	2.5-inch SATA	5 years
Western Digital Black PCIe SSD 256GB	\$110.99	256GB	2,050MBps/700MBps	170K/130K	PCIe NVMe	M.2	5 years

Inside The World Of Betas

MESEN 0.8.1

Nintendo's NES Classic Edition has been perpetually sold out since its release. People aren't really buying Nintendo Switch consoles so much as they're paying \$350 to be able to play the latest Zelda installment (on balance, still not a bad investment). If you're still looking for proof that the 8-bit NES is an immortal game console, we don't know what else to offer as evidence.

Prior to—and after, for that matter—the advent of the NES Classic Edition and Nintendo's Virtual Console, most old-school gamers got their hit of nostalgia using an emulator. (Please, consult your attorney before use.) Although this is far and away the most common use for NES emulators, our collective love of classic Nintendo games has also spawned a host of homebrew ROMs. Developed long after original NES consoles became fodder for hipster house parties, homebrew



Mesen 0.8.1

Publisher and URL: The Mesen Team; <https://www.mesen.ca>

ETA: TBD

Why You Should Care: Get a NES experience on your PC that's as close as possible to the classic console.

ROMs are essentially cartridge-less games that require an emulator to play. Consider Mesen, which has been under development for a little over a year and is an intriguing offering.

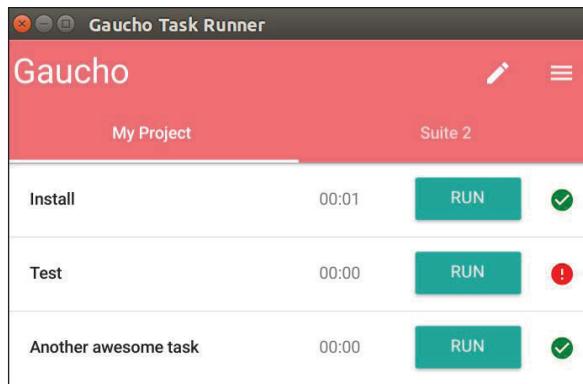
Multi-threaded and built in C++, Mesen tries to faithfully re-create the NES console. It has passed a staggering 157 of 158 TASVideos tests and offers a number

visual filters to give your ROMs that 19-inch Zenith feel. It has a built-in debugger, and the latest release improves emulation speed by 15 to 35%. Development is ongoing, too, so expect Mesen to be even better over time. When you feel like pressing pause on Breath of the Wild, Mesen is a blast from the past that should make any NES purist happy. ■

ANGRY KOALA GAUCHO 0.2.1

We admit it: We're often guilty of discussing power users only in the context of modders, overclockers, and other hardware enthusiasts. It's easy to get carried away when there's so much awesome hardware out there, but there are plenty of power users who are perfectly content using components at stock speeds while tweaking their system for better performance. For our power users that prefer to stick with software, Gaucho could be your Huckleberry.

Gaucho already scores points in our book for coming from a developer named "Angry Koala." But this open-source software's real appeal is how it proves that powerful doesn't have to be synonymous with complicated or Byzantine. Its UI is minimalist to the point of being nearly non-existent, yet it does what it needs to do without being ugly. For a program like Gaucho, you really don't need anything more.



Gaucho 0.2.1

Publisher and URL: Angry Koala; <https://angrykoala.github.io/gaucho>

ETA: TBD

Why You Should Care: Simple but effective, Gaucho wrangles all sorts of system tasks without being pretentious.

Gaucho is, at its core, a task and app launcher. Power users who spend a lot of time rooting around in their shell or terminal will get a lot of mileage out of this program. Adding and editing tasks is plain and simple, and Gaucho is of course able to juggle them in multiples. You can group tasks together into suites, then launch them with the Run button.

Angry Koala is also an inclusive koala. It's available for Linux, Windows, and macOS, so you can put it to work for you no matter what your preferred platform happens to be. The software is still in diapers; if you want to wait to trust Gaucho with your mission-critical work, as it were, we don't blame you. At the very least, though, it's already worthy of a test drive. ■

Upgrades That'll Keep You Humming Along

Although bears and soda feature prominently in this month's parade of updates, we are, as always, very serious about the safety and security of your computer. We assume you are, too, and thus recommend you take a look at updates to NoScript and TunnelBear. A new BIOS from GIGABYTE adds Intel Optane support to Z270-based motherboards.

SOFTWARE UPDATES

Bandisoft Bandizip 6.05

Since the release of version 6.0 in March 2017, Bandisoft has been steadily rolling out updates to its freeware ZIP archiver. The latest fixes an issue that didn't store the modified time for folders when the program compressed a 7z file, and it also eliminates a crash bug that occurred when users created a multivolume ZIP with a 1 byte split size. Version 6.04, released mid-April, corrected problems associated with encrypted archives. Specifically, modifying an encrypted ZIP could corrupt it, and Bandizip was asking for a password every time users attempted to extract an encrypted archive via dragging and dropping.

<https://www.bandisoft.com/bandizip>

Bitsum Technologies

Process Lasso 9.0.0.304

When you're ready to reclaim CPU resources from the legion of processes that have crept into your system over time, Process Lasso is ready to wrangle them. In truth, version 9.0.0.300 is little more than a maintenance update, but it's the best kind. According to Bitsum, the update "fixes some code issues that never manifested as bugs, but were nonetheless incorrect." How's that for being proactive? Of course, 9.0.0.300 comes on the heels of Process Lasso's big 9.0 release, which adds configuration profiles, provides a new view that lets you filter processes, cleans up the program's UI, and more.

<https://bitsum.com>

DesktopOK 4.66

Most desktop users don't have to worry about Windows' annoying habit of

reshuffling Desktop icons after a screen resolution change, but laptop users who regularly switch between a large standalone monitor and their laptop's screen frequently contend with this problem. DesktopOK helps you fight back, letting you save your icons' position according to the current display resolution. In the most recent update, DesktopOK now lets you edit desktop icon layout names by pressing F2. An update in late March (version 4.64) updated DesktopOK's language files and introduced a few unspecified "small adjustments."

<http://www.softwareok.com>

InformAction NoScript 5.0.3

If you're a Firefox user who ferociously guards your web browser (and thus, your PC) from incoming attacks, we'd wager you're familiar with NoScript, one of the most successful browser extensions for stopping JavaScript, Java, Flash, Silverlight, etc. in their tracks. After a rapid succession of release candidates, version 5.0.3 is now public, and it helps make NoScript that much better. Specifically, the update fixes an XHR regression and an issue where enabling JavaScript globally for HTTPS sites "[broke] the UI." There's one new feature, too. The addition of a "noscript.webext.enabled" preference gives users control over embedded WebExtension startup.

<https://noscript.net>

Soda Player 1.1.1

Soda Player is able to stream BitTorrent videos instantly, and it works with Chromecast and Apple TV. The latter receives a lot of attention from this most recent update, which should dramatically

improve Soda Player's quality and performance in general on fourth-generation Apple TVs. Specifically, the update fixes one bug related to switching subtitles while using AirPlay and another bug while seeking on fourth-gen Apple TVs.

<https://www.sodaplayer.com>

TunnelBear 3.0.35

This ursine VPN software is one of the best-looking privacy apps we've seen in a while—VPN or otherwise—and definitely worth a look if you're hunting for such a program. Version 3.0.35 updates TunnelBear to OpenVPN and fixes a small handful of hairy issues. The latest version corrects Windows 10's TAP Adapter and also fixes TCP Override. It also devours a bug that prevented TunnelBear from reconnecting after long periods of inactivity. Proof that software developers can have a sense of humor, TunnelBear 3.0.35 also includes "463% more bears."

<https://www.tunnelbear.com>

DRIVER BAY

Gigabyte GA-Z270-Gaming K3 BIOS F6

This new BIOS adds support for Intel's new Optane SSDs, if you're interested. GIGABYTE tends to push out BIOS updates to all of its boards with a particular chipset, so anyone with one of the company's Z270-based mobos should swing by the site to see if there's a new BIOS waiting.

www.gigabyte.us

Drone Racing

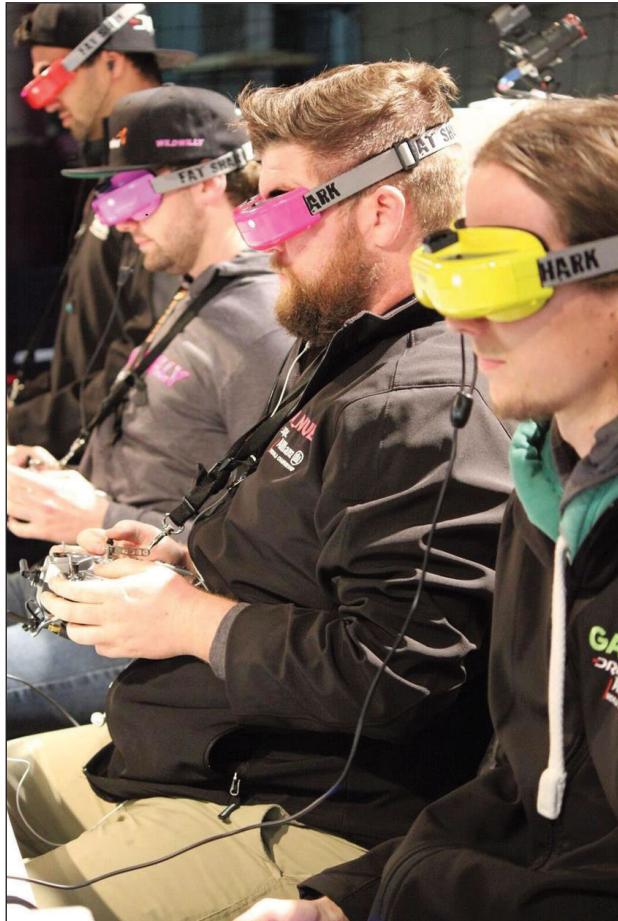
A Hobby Grows Into A Burgeoning Professional Sport

Watching a drone race can get intense. After all, we're talking about LED-bearing, propeller-twirling aircraft navigated by pilots to speeds of 80mph or faster buzzing like a pack of crazed black birds down narrow hallways, around flags, through hoops, and past other strategically placed obstacles. Then there are the crashes. They happen often and out of blue, such that the impact of two drones colliding in midair or a drone smashing into a concrete wall genuinely startles you.

Collectively, the crashes, high speeds, and pilots' superior flying skills on display have helped drone racing grow into a burgeoning professional sport. Commonly described as "flying robots" or esports happening in real world, drone racing shares traits with NASCAR and Formula One but also uses technology—FPV (first-person view) goggles, onboard cameras, radio receivers/transmitters, and more—in uniquely exciting ways to provide participants and spectators a super-charged bird's-eye view of the action not common with other sports. Drone racing is also the rare sport in which seemingly anyone can excel no matter the age, gender, or physical ability.

"Watching six drones take off and fly through one gate at one time is exhilarating, especially when there's destruction," says Rudi Browning, a 13-year-old highly ranked drone racer from Australia. As the sport's technology continues to advance, he says, pilots

www.booksmania.net



CREDIT: DRL

The FPV (first-person view) goggles that drone racers wear are described as letting pilots "see what the drone sees" as it is flying.

will only fly faster and longer. "If this continues, then who knows where we will be in the next few years," Browning says.

Already, drone racing leagues and organizations have attracted major partnerships and exposure from the likes of Mountain Dew, ESPN, The Discovery Channel, and notable investors. Beyond race series and national and world championships, drone racing is also featuring enough prize and sponsorship money that some racers are ditching their

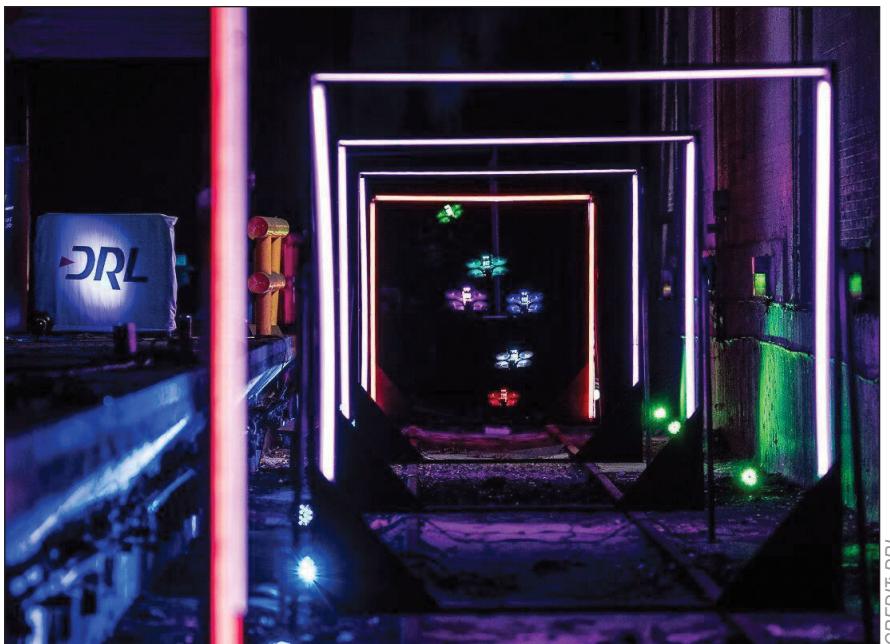
day jobs to race professionally full-time. The following looks at the sport's remarkable progression in just a few years' time.

A Sport In The Sky

Undoubtedly, 2016 was a pivotal year for drone racing, a sport that only really traces back several years to when hobbyists in Australia and California reportedly began gathering in parks, empty fields, abandoned buildings, and other locales to share a collective interest in two things humans have always been interested in: flight and competition.

By 2015, local race groups began emerging in increasing numbers. Soon, regional and national organizations surfaced and helped bring life to major regional, national, and international championship races in 2016 in such locations as Miami, Dubai, New York City, and Hawaii. Three more notable organizations driving the sport forward include the DRL (Drone Racing League), IDRA (International Drone Racing Association), and MultiGP Drone Racing League.

"There were several events that defined 2016 as being the breakout year for drone racing," says Justin Haggerty, founder and CEO of IDRA, which helped stage the inaugural World Drone Prix in Dubai. What happens this year will help determine if the sport's early momentum can continue, he says. "Drone racing is a young sport that's growing globally, but the community remains small," he says. To succeed, "the human experience must drive its culture," he adds. That's why IDRA is holding its Drone Racing Series and IDRA



to be associated with massive blue-chip companies like Allianz,” Horbaczewski says.

DRL actually considers itself a technology company. As such, while racers in other organizations build, modify, customize, and repair their own race drones, DRL racers fly identical aircraft DRL builds in-house. “That’s important in a few ways,” Horbaczewski says. “One, it levels the playing field, so when a pilot wins, you know it was pilot skill that drove the victory and not a slightly faster drone.”

Crashes also factored into the decision. “Drone racing is a sport that involves a lot of crashing, and the races are relatively constrained by both the crash rate and the battery life. So you need a lot of drones,” says Horbaczewski. DRL brings 500 drones to each race, which enables more expansive racing than if racers “show up with a homemade drone,” Horbaczewski says. “I just don’t think there’s a professional sport out there that people use homemade equipment as the primary equipment of the league,” he adds. Using in-house drones also enables DRL to gather data from the onboard CPUs to improve performance. DRL’s proprietary

Unlike other race leagues and organizations, Drone Racing League builds all the drones used in its races in-house, with the theory being that the best pilot wins a race and not the best drone.

Challengers Cup as open-registration and publicly held events, Haggerty says. The organization recently completed a Challengers Cup race in Istanbul.

In terms of backing, Haggerty says investors and media platforms have recognized drone racing’s potential, but not all have been a good fit. As such, IDRA walked away from various early opportunities, including a three-year deal with ESPN. Now, IDRA is emphasizing an online-platform strategy that includes partnerships with Dailymotion and a three-year distribution deal with Amazon Prime Instant Video.

Although 2016 marked DRL’s first year, it managed to ink several deals, including one that saw ESPN air its races. “In 2017, we’re taking everything we learned last year and enhancing the sport with it,” says Nick Horbaczewski, DRL founder and CEO. That means more races and DRL’s first international races in places such as Munich and London.

“We’ve also substantially upgraded our technology, which allows us to race on larger courses in more interesting places with faster drones,” Horbaczewski says. “That will really enhance the viewing experience.”

Recently, DRL partnered with Allianz to make the global insurance company the title sponsor of DRL’s 2017 race circuit. “I think it really changes the position of the sport



Many drone race events, including ones the MultiGP Drone Racing League helps stage, go beyond just holding races to include educational and instructional workshops that teach newcomers how to build and race drones.

radio system, meanwhile, helps address challenges concerning racing indoors at very high speeds, Horbaczewski says.

Heavily investing in technology is what Horbaczewski believes separates DRL

from other organizations that have tried to build professional drone racing leagues but have fallen short. "It was sort of a faulty assumption to assume the technology to do this on a professional scale existed. It

didn't," he says. "The technology to do it on an amateur scale existed, but the gap between what you need for a professional event and an amateur event is huge."

Learning Through Competition

While DRL racers use identical drones for competition and race-ready kits are also available to buy, a large swath of drone racers build, mod, customize, and repair their own drones. Michael Gianoutsos, MultiGP chief marketing officer, says these areas of interest are what create the great sense of community among racers. "There are guys out there really interested in the software, but there are guys really interested in making the frames, and then other guys are really into organizing events. There are all these spheres of influence that you can go into, and it helps grow the community," he says.

MultiGP has worked to round up, provide direction to, and transform hundreds of local drone race groups into formal race chapters while maintaining a community vibe. The organization claims about 15,000 registered users and 1,000 volunteer-run race chapters. "In the same age of social media, we started to see Facebook [drone racing] groups starting to pop up," says Gianoutsos. Using a grass-roots approach, MultiGP is working to put a coach and race field in every chapter city, something that's creating a conduit for direct communication that "keeps us all connected," says Shawn O'Sullivan, MultiGP head of press relations.

MultiGP has also worked to bring uniformity to the various race formats and race classes that local groups use. "That's ultimately the best way to succeed, having something that's repeatable," O'Sullivan says. Thus, on any given Sunday, MultiGP can help stage "a high-quality event anywhere from Boston to Bulgaria," he says. In October, MultiGP will stage a national championship event in Las Vegas featuring racers who've advanced from about 15 regional qualifiers. Beyond racing, though, MultiGP requires chapters to stage constructive workshops, including to help newcomers learn how to build and operate race drones.

Virtual Practice Makes A Drone Racer

Talk to anyone involved in drone racing and you'll hear basically the same warning: You're going to crash your race drone, and probably sooner rather than later. Even experienced pilots of hobbyist drones will find piloting racing drones much different due to the greater speed and extent to which pilots are in manual control of every aspect of flying, drone racers profess.

A simulator is one way to gain racing experience without real-world ramifications. DRL (Drone Racing League) offers the well-known, multiplayer Racing Simulator, which the organization itself claims can "save you a ton of money considering the amount of crashing that can happen when first starting out." Available for Windows and Mac systems and supporting compatible console and drone controllers, the simulator offers virtual versions of actual courses that DRL racers race.

Nick Horbaczewski, DRL CEO, says one challenge drone racing faces is that there's a pretty high barrier of entry into the sport. "Someone has to be interested and passionate enough to go out and learn all the hardware design and software, and once they've done all that, they need to learn how to fly it," he says. "And learning how to fly it can be a painful process. This is a very high-skill activity, and I think people sometimes confuse that." Compared to a hobbyist drone that "kind of flies itself," Horbaczewski says race drones are fully manual-performance aircraft.

Horbaczewski himself learned to race drones using DRL's simulator. "I was actually competent enough I could fly it and focus on getting better as opposed to just repairing my drone that I crashed every couple of seconds," he says. Broadly, the simulator is one area DRL is investing in to make entering the sport easier. "If a 9-year-old sees this on TV and says, 'That's really cool,' they can download the game and play it, and they're off researching drones and learning about design and getting technology," he says.



Drones made specifically for racing are often described as being more difficult to fly than commercial hobby drones due to the amount of manual control involved. Drone simulators, such as this one from Drone Racing League, let would-be pilots get up to speed before trying the real thing.

DRL is also using the simulator to discover new racers. In January, it partnered with Bud Light for the 2017 Bud Light DRL Tryouts where 24 participants converged in New York City to compete live for a \$75,000 pro contract for DRL's 2017 race season. "Now he's traveling around the world with us and flying in real races," Horbaczewski says. "What other sport gives you an opportunity to try out for a real sport through a virtual simulation that translates to real life?"

Many people enter drone racing with or through a parent, child, spouse, sibling, friend, or other connection, something that sets up natural student-mentor opportunities. Layering STEM opportunities in drone races also has many people within the sport excited. As Horbaczewski says, "What other sport exists that has real social value for the participants to learn really valuable skills in educational areas? It's fantastic to see that emerge."

At MultiGP events, chapters commonly reach out to PC, virtual reality, and other potentially interested parties. "Everyone

that loves technology is coming in," says Gianoutsos. "The other cool part is we're seeing a lot of youth come in because the fathers have realized drone racing is a really neat hybrid between a videogame and real life." That element is getting kids active and socializing with others to learn about software, electrical engineering, and other skills they can apply elsewhere.

O'Sullivan, who dubs MultiGP race events the "modern generation's Pinewood Derby," says the multi-generational connections drone races enable are crucial to the sport's growth. He points to a recent regional qualifier race in California won

by an 11-year-old boy. "Drone racing is a father-and-son activity for him and his father," O'Sullivan says. "Not only that, they have a three-generation connection. His grandfather also goes to the events, and he has a history in aviation engineering. It's that interaction that we find so fascinating."

Broadly, O'Sullivan says drone racing taps into a primal desire humans past and present have shared to experience flight. "It doesn't matter what nation you live in, at one point in time every human being dreams of flight," he says. "That's something we can actually achieve every single weekend, and the ability to pass that

Make Space For The Big Boys

Australia's Freedom Class Giant Drone Sports believes bigger is better where drone racing is concerned. The racing drone it's creating is about 10 times the size of typical race drones. Freedom Class believes that makes for a better live race experience. The following is part of our conversation with Chris Ballard, the organization's co-founder.

Q: What benefits do giant drones provide that smaller drones might not?

CB: Given the huge size (about 4 feet across), coupled with the massive power-to-weight ratio (60kW of electric motor power and overall weight of about 66 pounds), there's a lot of space for equipment that the smaller aircraft cannot accommodate. This includes a full autopilot system with GPS that allows for numerous safety features, as well as the addition of geo-fencing; telemetry that allows 50 different bits of data to be communicated every 200ms, allowing for enhanced broadcast information, live visual tracking, and pilot and aircraft strategy management among many other possibilities; and HD video systems that allow a digital video stream to occur, providing significantly better visuals over the current norm in drone racing. Apart from those digital aspects, these aircraft are large enough to watch as a spectator. You can see them, hear them, and really feel them as they roar past, shaking the very air.

Q: What purpose will the Freedom 500 Series satisfy?

CB: The Freedom 500 is the step up from regular drone racing that's necessary before a pilot can become a Freedom Class pilot. The Freedom 500 is roughly twice the size of a regular racing drone in a package that's significantly more aerodynamic than the popular flat-plate design of the regular racing drone. This extra size allows us to place the same systems that the Freedom Class has, making it suited for live broadcast, as well as being a perfect training system for drone racing pilots looking to step up their careers at an affordable price point. To become a Freedom 500 racer, the pilot must first undergo the Freedom safety training and

licensing system, a first in the world of drone racing. Freedom Class will be selecting the best pilots from the Freedom 500 series to undergo initial training and testing on the Freedom Class Giant Racing Drones.

Q: How does designing, prototyping, and piloting a giant drone compare to smaller drones?

CB: Designing a Freedom Class isn't comparable to a regular racing drone. A regular racing drone is cut from flat carbon fiber sheets, usually between 3 and 6mm in thickness and held together with nuts and bolts. It usually weighs about 0.7 to 1.4 pounds and has up to 2kW of total power. The Freedom Class is designed from the ground up to be aerodynamic, so it's a necessity to use molded carbon fiber to form the shell, which additionally adds strength and rigidity that is a must when dealing with 60kW of electric motors. The Freedom Class V1.0 was handcrafted carbon fiber, initially created as a testbed for the power train, which worked beautifully. The airframe, however, started to experience significant vibrations at about 99mph, which lead to the total redesign of the chassis and surfaces. The firmware the Freedom Class uses and the Freedom 500 used is a key difference to a regular drone racer. This software is meticulously tested and accredited to the highest of international aviation standards: DO-178C at its highest level of criticality (DAL-A).

Q: What are Freedom Class's plans for the near future? Is an inaugural race planned this year?

CB: We're taking a measured and holistic approach to creating an inaugural race leading to an international series. We're ensuring that the Freedom 500 and the Freedom Class adhere to strict and in-depth safety systems and structured operational procedures, from the design process, manufacturing phases, and initial testing to the pilot training and licensing. Once that's completed to an international standard, we'll be announcing our inaugural races.

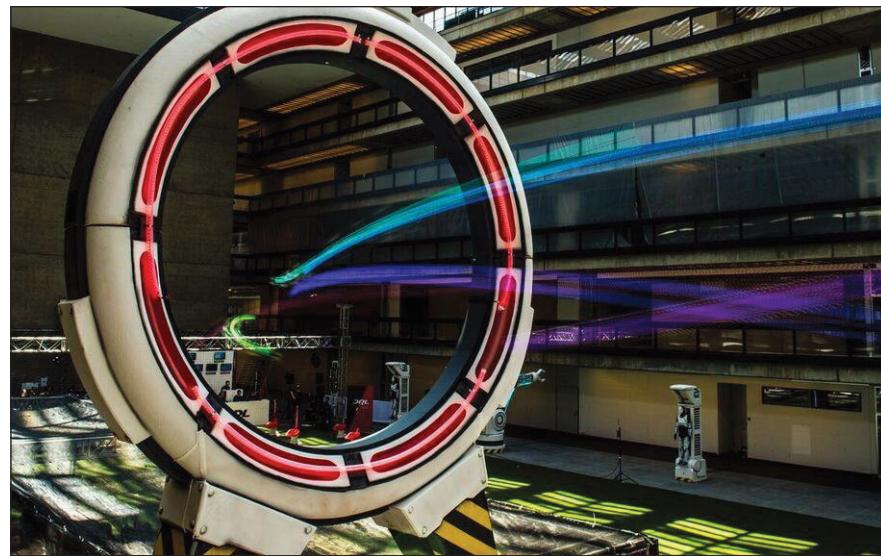
on to other generations above and those coming after us is very important and one of the foundation stones of MultiGP."

Flyers, Start Your Propellers

One of the most unique traits of drone racing is that it doesn't discriminate. As O'Sullivan says, drone racing is a "truly agnostic sport" in that it doesn't recognize age, race, sex, or physical ability. "This is something that almost everyone can do," he says. Similarly, Horbaczewski says what makes drone racing so wonderful is that it crosses age and gender boundaries. "You can have a 9-year-old and 50-year-old racing on the same track, and there isn't any inherent disadvantage there," he says.

Luke Bannister is evidence of this. The U.K. native won the 2016 World Grand Drone Prix and its \$250,000 top prize at just 15 years old. Australia's Rudi Browning is just 13 but already has several sponsors. He placed 13th at the 2016 Drone World Championships in Hawaii. "I've been flying drones for about two years now and am loving every minute of it," he says. "It's a high-adrenaline sport and is very exciting."

Despite intense competition, pro drone racer Travis "M0ke" McIntyre says racers are ultimately all friends who look up to each



For several obvious reasons, many people describe drone racing as esports playing out in the real world. Like esports, drone racing isn't physically demanding, meaning essentially anyone can take part. Mentally, however, the sport requires extreme concentration and execution.

other as pilots. "The competition is fierce, and people will get upset when they aren't doing as well as they think they should, but at the same time, everyone realizes we are playing with toys, so the atmosphere is usually pretty light," he says. In fact, if a racer is experiencing a problem, McIntyre says "there are usually two people trying to help."

Competition-wise, drone racing is mentally taxing. In that way, it's similar to esports, says McIntyre, who started flying drones to freestyle, do tricks, and "fly cool spots" before turning to racing. "Besides moving around your thumbs, you aren't doing much moving," he says. Mentally, however, "you have to strategize and look for lines prerace and during practice, and when it comes down to the actual racing, it's just intense focus and concentration."

Cost-wise, drone racing is relatively affordable to enter compared to other sports, including auto racing, which it's often compared to. "I love racing. My dad competed in the NHRA for 18 years," says Haggerty. Unfortunately, he adds, car racing is also extremely expensive for most people. "Don't get me wrong, building \$500-plus drones and crashing often is expensive," Haggerty explains. "However, the financial barrier to entry in drone racing is far lower than in auto racing. It's for this reason that drone racing will become one of the leading motorsports in the world."

McIntyre estimates it takes about \$1,000 to buy everything needed to race with friends in a field if the pilot can learn from online resources and solder and has a basic knowledge of electronics.



A major component of drone racing is the DIY mentality that pilots possess in terms of building, modifying, customizing, and repairing their own drones. Many credit this mindset for helping build the community atmosphere that drone racing is said to offer.

Becoming more competitive requires “spending a lot more money and time,” he says, particularly to stay current with the new products constantly coming out. “While I’m one to wait and see what other people have to say about [new products], there are plenty of people who are constantly buying all the new stuff looking for that edge,” McIntyre says.

Buying a kit can allow a racer to “just plug and play,” but this route can mean considerable upkeep costs, McIntyre says. Propellers are cheap, for example, but a racer can easily go through several sets a day. There’s also a time investment to consider. “Not only does it take time to learn to fly and get good at it, but repairing drones and troubleshooting problems takes up a big chunk of time, too,” he says.

Browning estimates 50% of drone racing is spent on repair, modification, customization, and building tasks. “Every single part is soldered together and is then programmed and tuned to fly however you may like,” he says. Racers also must understand how different frames, motors, propellers, and other components impact flight traits. “Modding drones is important, because at a high level of racing, you need different drones for different tracks,” Browning says. “Each drone may vary in speed, efficiency, torque, or flying time. It just depends on the day.”

As for race formats, McIntyre says there are two main types: racing once with the result determining the pace or racing multiple heats with overall points from each heat determining final standings. Because luck can largely factor into races, McIntyre says multiple-heat races seem to be the better system. “When it’s a one-heat race and you have a midair collision off the start, you’re out. Whereas in a multi-heat system, you could still win if you do well in the other heats,” he says. The different formats also influence the pilot’s given strategy. “Flying conservatively in a multi-heat race can get you more points if you’re consistent and other competitors aren’t,” McIntyre says. “If it’s a one-heat race, you’ll probably push yourself a little harder to get a top spot.”

Drone Racing & STEM

While the STEM opportunities created by drone racing don’t typically receive a lot of attention, they have tremendous potential. In Baltimore, for example, drone company Global Air Media recently announced a Baltimore Drone Racing League for students, along with a partnership with a local makerspace organization to enable workshops that teach students and adults how to build and fly drones—skills that could translate into jobs and careers in a quickly growing sector.

Last fall, the IDRA (International Drone Racing Association) hosted a congressional briefing to announce a nonprofit UAS (unmanned aircraft system) STEM Alliance that governmental agencies, congressional members, and corporations will participate in. IDRA CEO Justin Haggerty says promoting STEM education via drone technology and racing and thus establishing middle and high school drone programs will help “create the engineers and pilots of tomorrow” while also helping the drone racing community flourish.

Nick Horbaczewski, DRL (Drone Racing League) CEO and founder, says numerous high school drone race leagues are already surfacing. “I’ve talked with some of the teachers involved in some of those efforts, and they love it because in their minds, [students are] learning hardware. They’re learning software. They’re learning robotics,” he says. “It’s rare you see science becoming sport in a way that’s convincing to both the science teacher and student-athlete. That’s what makes drone racing so special; it’s a true form of STEM education wrapped in a form that’s exciting for the participant.”

As drones continue proving their commercial worth, more people are understanding the skill involved in flying them. “And we see it trickling down to schools,” says Michael Gianoutsos, MultiGP Drone Racing League chief marketing officer. In addition to high schools and middle schools, elementary schools are reaching out to MultiGP. “They want to know, ‘How can we get kids interested in new technology?’ This is one carrot that kids love because it’s fun and cool,” he says.

Drones also have the ability to get kids outside, says Shawn O’Sullivan, MultiGP head of press relations. “Not like PokéMon GO, but actually bringing them outside and keeping them outside,” he says. “When you figure the average cost of involvement is about the same price as a videogame system, you can get into drone racing and get off the couch,” he says. Once kids are able to understand the concepts of the drone, or “STEM in a box,” as O’Sullivan says, they get hooked and “want to be outside more.”

Horbaczewski sees drone racing enabling a “wonderful crossover” where someone can transition from seeing drone racing as something that’s cool to actually becoming competent in areas that STEM programs are designed to encourage students to get involved with. “I think you’re seeing people in the sport who probably wouldn’t have gotten interested in those areas getting extremely interested and becoming sort of experts so to speak because of their passion for the sport,” he says. “To borrow a phrase, [drone racing] is almost the ‘gamification of STEM.’ I think it’s an amazing opportunity, especially for educators who struggle to find a way to make these students want to get excited about these topics they should be excited about.”

For those interested in racing drones, Browning advises against buying “cheap rubbish and clones” because they often break quickly. Instead, seek out sellers that specialize in drones, as they’ll have everything needed and typically offer great customer service and advice, he says. Browning also

points to social media as an excellent resource for advice. “There are many forums full of intelligent people who are more than willing to help out,” he says. “However, when it comes to race day, most pilots play their cards close to their chest. It often gets quite competitive, but that’s all part of the fun.” ■

Yeah, we know you have blogs to post, video to encode, reports to write, and code to compile. We do, too, but you have to take a break once in a while (and maybe blow some stuff up). That's why each month we give you the lowdown on what to expect from the latest interesting games.



Everything is a game that a certain contingent of people will complain isn't a game. Typically, these minimally interactive experiences—often pejoratively referred to as walking simulators—tend to focus on a narrative, and when the story is well done, we're willing to forgive the inability to fire a weapon, wield a pick axe, or drive a car. This game, however, doesn't have a coherent narrative thread in any form. What it does have, though, is everything else.

In David O'Reilly's Everything, you start out as a spec of light cruising through space. "Press X to think" and text pondering the nature of your existence appears. And then you're a brown cow, rolling end-over-end through a grassy low-poly valley. There are a handful of trees, rocks, bushes, monkeys, bears, tufts of grass, and a small swarm of bees buzzing around.

There's a hazy circle at the top of the screen and occasionally arrows appear at the circle's edges. The top and bottom arrows indicate the opportunity to ascend and descend by clicking and holding the right and left mouse buttons and selecting the triangles, respectively, which amount to zooming into or out of the current realm. For instance, descending into an ant from the cow shrinks your view so that you become aware of items that are similar in scale, such as leaves, mushrooms, worms, beetles, and pebbles. Descend again and you'll go microscopic, joining the company of protozoa, DNA, molecules, elements, and plant pollen. When you encounter the arrow at the top of the circle, you can ascend through the realms up to galaxies, then a

The End-All Be-All Of Walking Simulators

BY ANDREW LEIBMAN

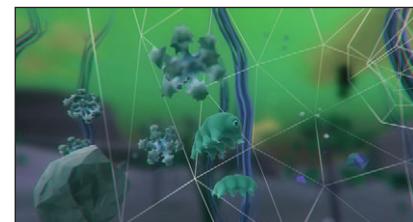
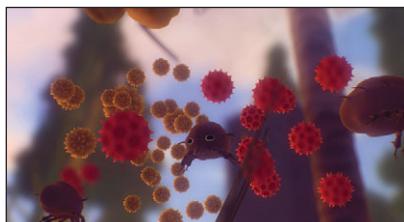
\$15 (PC, PS4) • ESRB: (E)everyone
Double Fine Presents & David O'Reilly • www.everything-game.com

realm of kaleidoscopic pulsating shapes and theoretical particles, and back to the microscopic realm again. When an arrow appears on the right or left side of the circle, that means there's a nearby opportunity to shift your control to something larger or smaller within your current realm. Click and hold the right or left mouse button again, then release it when the circle at the center of the screen intersects with the circle around the object you want to become.

As you transfer to more things, you collect them, eventually unlocking the ability to transform into anything you've collected. Over time, you'll unlock the ability to change the scale of anything. Aside from the drive to merely collect stuff, the game lets you band together things of the same type or things that are similar, or just create a massive group of everything you encounter. You can also dance when in a group of two or more or talk to various things to hear them talk back and react via stylized emoticons.

As you explore, you'll come across thought bubbles and audio prompts that trigger a recorded snippet of a lecture from famed philosopher Alan Watts. At this point, it's safe to say that Everything is not for everybody, but if you're intrigued by Watts' musings, they do manage to add some colorful context to your explorations. In a bizarre twist for a game full of bizarre things, you can even put down the controls and the game will start to play itself. Documentary mode, which randomly cycles through things while displaying a Wikipedia-sourced description, has become our favorite screensaver.

As long as you're not opposed to a game being described by the phrases "interactive experience," "existential philosophy," and "rolling bears," you, like us, may find yourself thoroughly enjoying what Everything has to offer. ■





There isn't a lot of competition in the subgenre of combat racing, so you know that when a well-known franchise like FlatOut launches a new installment, there's bound to be an eager fan base ready to accept it with open arms. Having played the game, however, that fan base instead should be throwing up those arms.

We can't fault FlatOut 4: Total Insanity for its stable of cars that only vaguely look like cars you'd recognize, a soundtrack full of ear-splitting indie garage punk, or for the "dozen NPCs" that really consist of two character models wearing six different kinds of face paint. At \$39.99, we don't expect FlatOut 4 to have the music and car-licensing deals of a Forza game or a small army of artists churning out assets.

As a blend of destruction derby and racing, your primary goal is to win, either by being the fastest or by slamming your faster opponents out of the way. There are 20 tracks to race through in a decent mix of climates and environments. Alternative game modes include time trials, destruction derby arenas, assault races (think Mario Kart-style combat), and a bizarre series of mini games in which you eject the driver into the air and earn points.

When you start the game, you only have enough cash to buy one of the two starter cars in the Derby class. There are also Classic and Allstar classes, and each has a series of unique races and exclusive cars. There are 27 cars in total, but the "design it once and paint it a different color" philosophy also applies here. The Cookie, Derby Cookie, and Cookie Offroad, for instance, are all the same elongated VW Beetle look-alike. The pickup truck model was mixed and matched with a snow plow, open

Driven Insane

BY ANDREW LEIBMAN

\$39.99 (PC, XOne, PS4) • ESRB: T(een)

Strategy First/Tiny Rebel Games • www.strategyfirst.com/FlatOut/

bed, tow truck bed, topper, and a handful of other accessories to form the Snow Bane RX, Snow Quarterback, Yoozfool Ice Breaker, and Yoozfool Toe Truck. By our count, there are closer to 10 unique car models.

For whatever reason, the majority of the cars tended to oversteer to the point of spinning out. The cars also feel extremely heavy, which might be a good thing in a car combat game, except that hurtling into fellow racers is just as likely to throw you into the weeds as it is to give you an advantage. We lost several races because our car was "destroyed," but we never once witnessed an NPC-driven car get similarly disqualified. Despite the mix of terrain, it seems like the cars grip the same whether they're on concrete, dirt, or snow. Even with a fully-upgraded car, you won't be drifting around corners in this game.

Like everything else, the tracks are locked behind a progress wall. Although they look gorgeous and offer a good mix of off-road and tarmac sections, several of them are poorly designed. A few tracks have at least one insidious invisible bump that'll send your car spinning out of control. Having a lead foot is also punished anytime you catch air and land without letting off the gas and steering wheel. Some bits of debris let you clip right through them, while others will kill your momentum or toss you out of bounds.

We love a good arcade-style racer, but what we don't love is the unpredictable physics and brick-like car handling. If you want to upgrade your car, prepare to race the same event again and again to earn money. If you want a new car, prepare to grind, hard. A game with FlatOut's pedigree should be fun, but FlatOut 4: Total Insanity just made us want to throw the controller. ■



VIKINGS

WOLVES OF MIDGARD

Developer Games Farm has been making isometric action-RPGs for some years in the form of its Heretic Kingdoms titles, which borrow heavily from Diablo in terms of their interface, mechanics, and so on. For its latest release, Vikings: Wolves of Midgard, the Games Farm team has shifted its focus from traditional fantasy to Norse mythology, and the result is a pleasing if mindless hack-and-slash game set in cool environments that tosses in a novel game mechanic or two.

Vikings is available on the big three current platforms: PC, Xbox One, and PlayStation 4. I played it on PC, where it is playable with mouse and keyboard or with a control pad; playing on the PC will also save you a cool \$20, as the game retails for \$59.99 on consoles. I tried both control sets, and while both are serviceable, I preferred the game pad as the game leans heavily on your character's roll mechanic to avoid damage in combat. In encounters with multiple enemies (which accounts for the majority of the fights), using the left stick to run and the right stick to roll works pretty well, and the game maps the abilities you acquire as you level up to a few buttons that are by and large pretty easy to manage.

At the outset of the game, you'll find a pretty limited selection of character customization options; you choose your Viking's gender, hair style, tattoos, and the like from a short list of options, and then you pick a class in the form of allegiance to a particular Norse god. Each god grants followers a number of "gifts," which are the abilities you'll use in combat when you want to move beyond mashing the attack button, and each god's gifts are based on a particular style of combat. If you choose Thor, for instance, you'll want to stick to large, two-handed axes, hammers, and swords. Choose the goddess Skathi if you want to play with a bow, Loki if you want to dual-wield smaller weapons, Odin if you favor a staff, and so on.



We Are Your Diablo-Style Overlords

BY CHRIS TRUMBLE

\$39.99 (PC), \$59.99 (XOne, PS4) • ESRB: (M)ature
Kalypso Media • www.kalypsomedia.com/en

In the game, the Norse legend of Ragnarok, the war that ends all nine worlds, has begun. The Jotan and other foes are vying with the gods of Asgard for supremacy, and the humans of Midgard (Earth) are caught in the crossfire. After a brief introduction and some training-wheels combat, you'll become the Chieftain of Ulfang Village, which has been destroyed and is in dire need of some leadership. As leader, you will work to rebuild your village and protect it by battling first with nearby clans that threaten, and with greater foes as the game progresses. In between missions, you can visit Ulfang's various tradespeople to sell or dismantle the gear that piles up in your bags as you fight, and to craft new items.

Missions largely consist of hacking your way through a sprawling level and picking up collectibles in the process, then arriving at a final arena at the end of the level and heading in for a boss fight. The boss fights are challenging but not brutally hard on normal difficulty, and each has its own unique fight mechanics that you'll need to figure out and counter to survive.

Along the way, you'll collect the blood of your fallen foes to sacrifice to your god of choice—this is how you level up—and you'll find and win cool gear to upgrade both your character's look and combat effectiveness.

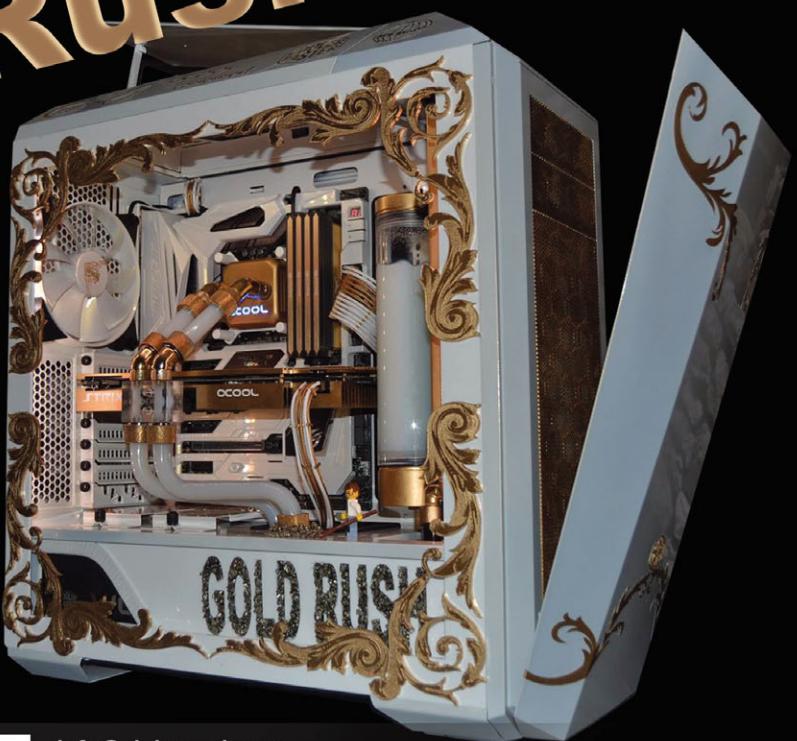
Games Farm and publisher Kalypso Media didn't reinvent the wheel here by any means, but the bugs that plagued the PC version's early days have seemingly been mostly ironed out, and thanks to some really nice visuals and fun combat, I enjoyed my time with the game. There's a two-player co-op mode if that's how you roll, and nice touches like quasi-destructible environments (you can knock structures down on/out from under your foes and damage them) and the need to avoid freezing to death in parts of some levels help keep the formula fresh. ■



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Q&A With Nir Eyal

How Products Hook Users For Better & Worse

Try to think of the last time you saw an advertisement for Facebook, Twitter, Instagram, or a similar tech product that relies on high levels of user engagement. It's quite possible you can't. Why? Because these companies don't really need to advertise; their users keep coming back on their own. Why? It is Nir Eyal's contention that such products have steps embedded in them that help create habit-forming behaviors in users. It's this area of "behavior design and habit formation" and "how technology persuades people" that Eyal has spent years researching and writing about, including for a book titled "Hooked: How To Build Habit-Forming Products."

Eyal—who has worked in the videogame and advertising sectors, founded and sold two companies, and taught at the Stanford Graduate School of Business and Design—wrote "Hooked" for product designers, engineers, startup founders, and others to help them "create user habits that stick." His Hook Model illustrates steps he discovered are common among products that do so. In particular, Eyal sees great potential in creating habit-forming behaviors in products that can positively impact users while also helping users avoid the downsides of "digital distraction." We spoke with Eyal about how products can form habit-forming behaviors, the Hook Model, the moral responsibility companies have to help certain users, and more.

(You can read our full conversation at www.computerpoweruser.com/24314)

Q : Your book essentially informs tech companies how to create habit-forming behaviors in users to hook them into their products, and your Hook Model illustrates this. What habits and behaviors do habit-forming products such as Facebook, Twitter, and Instagram form with users?

NE : The most important thing to know is that there's no rule that says the best product wins. In Silicon Valley, the digital graveyards are full of companies that had the best technological solution. We could go on and on with companies that built the best whiz-bang technology that did amazing things, and yet customers didn't use the product. There's no 11th commandment that says just because your product is technically better that you'll win. In fact, it's not the best products that win. It's the products that capture the monopoly of the mind, meaning the product we turn to first with little or no conscious thought, that we're going to turn to time and time again whether or not there's a better competing product out there.

You don't check Google and a moment beforehand deliberate, "Is Google the best



possible search engine?" every time. In fact, head-to-head comparisons between Google and Bing show there's a 50-50 preference split. People can virtually not tell the two apart when you strip out the branding. But we don't ask whether Google or Facebook or Slack or WhatsApp or any one of these other services are better than the competition. Why? Because we use

them habitually. The best definition of a habit is a behavior done with little to no conscious thought. So if you're a company lucky enough to own that consumer habit, you have a huge competitive advantage because people won't even consider the competition once a habit has been formed.

Q : How does the Hook Model illustrate this?

NE : My book is centered on this design pattern that my research uncovered that's endemic to all sorts of habit-forming products. When you think about the kinds of products that people use with little to no conscious thought everyday—products like Facebook, Twitter, Slack, WhatsApp, and Snapchat, and just as much in the enterprise space, by the way, as the consumer space, there are equal examples on both sides—you find the same pattern. The pattern is four steps built into the design of the product that, through successive cycles, is how customer preferences are shaped, how our tastes are formed, and how these habits take hold.

Every hook starts with a trigger, which is something that tells the user what to do next. There are two types of triggers. One is external triggers that give the user some piece of information on what to do. For instance, Click Here. Buy Now. Play This. Things like that that give the user some piece of information. We in the design community, the engineer community, we know all about this call to action. We know all about these external triggers, but what I found people don't think about

are examples of these internal triggers and how we attach products to some of these uncomfortable emotional states.

It's very important to realize that there's only one reason why we use any product or service: The purpose of products is to modulate mood. That's it. When you look at the fundamental truth of why we use stuff, it's only to change how we feel. And you can be very technologically savvy and build amazing solutions, but if you don't understand what itch you're scratching

put them in this little box that we know today as the Skinner Box, and he gave them a reward. A little food pellet every time they would peck at a disk. At first, he would do that on a predictable schedule. If the pigeon pecked on a disk, it would get a food pellet. So he could train these pigeons to peck at the disk whenever they were hungry.

But then Skinner did something a little bit different. He added a variable reward. Sometimes, the pigeon would peck at the disk and nothing would come out. No

You can be very technologically savvy and build amazing solutions, but if you don't understand what itch you're scratching psychologically for the user, there's a very high chance your product will fail.

enough is the second type of trigger, which is the internal trigger.

The internal trigger is something that tells the user what to do next but where the information for what to do is stored as a memory inside the user's head. The ultimate goal of a habit-forming product is to attach itself to an internal trigger so that an external trigger is eventually no longer required. If you think about it, you almost never see an ad for Facebook or for Slack or Instagram or Snapchat because the ultimate goal of these products is for you to trigger yourself to action. That's where the power of forming a habit is such that once you create an association with an internal trigger, you don't have to spend money on expensive advertising or spamming people's inboxes because people trigger themselves to use the product. These internal triggers are typically negative emotions. When we're bored we check Reddit or YouTube. When we're uncertain, we Google. When we're lonely, we check Facebook. Those

psychologically for the user, there's a very high chance your product will fail. That's all about the trigger phase.

The next step of the Hook Model is the action phase. The action phase is all about constructing an action that's as simple as possible to get the reward. To scratch the user's itch. So scrolling on Pinterest, searching on Google, pushing the Play button on YouTube. That's an incredibly tiny action, but it provides an immediate reward. That's a little bit about the action phase, but there's much more.

Then comes the reward. The reward phase is where the user gets what he came for, but a common misconception is that people think, "Well, if I just give the people what they want, that's enough." But it's not. It turns out that to form a habit, the products from these world-changing companies like Facebook, Instagram, and the others, they don't just provide a reward, they use what's called a "variable reward." This comes out of the classic work of B.F. Skinner. Skinner took these pigeons and

food pellet. The next time the pigeon pecked at the disk, it would receive a reward. What Skinner observed was that the rate of response, or the number of times these pigeons pecked at the disk, increased when a reward was given on a variable schedule of reinforcement. Now, we see this in all sorts of products and services both online and offline. When we think of anything that has a bit of mystery, a bit of anticipation, a bit of uncertainty, this is what brings people back time and time again. Scrolling through your News Feed. Watching a sports game. Getting back on Slack to figure out what the latest update was to the project you're working on. All of these things utilize an element of uncertainty and variability. That's something we find highly engaging and habit-forming.

Finally, the last step of the Hook is the investment phase. The investment phase is all about getting people to put something into the product in anticipation of a future benefit, and this is a really big deal. Product

designers and developers don't think about this enough. The beauty and promise of interactive technologies is that the user can make the product for himself. So the investment phase is really about getting people to put data, add content, accrue followers, or perform some other learned skill or reputation on the platform. They make the product better and better with use so that over time, it appreciates with value. It gets better and better with use, and therefore becomes harder and harder to leave.

Now, the other thing that investments do is load the next trigger. They bring you back on your own. For example, when I send someone a message on Slack, there's no immediate gratification. What I'm getting is that I'm investing in a platform in order to get a reply. When that reply comes back, it comes back in the form of an external trigger that prompts me through the hook once again. That notification telling me that someone has replied is the external trigger for the next cycle through the Hook. And through these successive cycles, habits are formed, and eventually I won't even need those external triggers. Now, I'm using the products purely when I'm prompted with my internal triggers, those emotions, to use the product again and again and again, and a habit is formed.

Q : You've described Facebook as one of the most habit-forming products of all time. What traits and characteristics have you found that habit-forming technologies such as Facebook share?

NE : Facebook has an excellent hook. The hook is very clear. The external trigger is the notification. The internal trigger is feeling boredom or loneliness or seeking a connection—something people experience very frequently throughout their day. The action is to just open the app and scroll the feed. Very, very easy. As soon as we start scrolling the feed we get rewarded with all these things we see in our News Feed. What videos did people post? What did the comments say? How many likes did something get? A high degree of variability when it comes to checking our News Feed. That's, of course, the variable reward phase.

And the investment is that every time I friend someone, like something, comment, post, any time I do that I'm storing value in the product. I'm co-creating a product with Facebook so if you were to log in to my Facebook account, it would be boring to you because it's been customized based on the data I invested in the platform. So Facebook has a very, very good hook, and it's a great explanation for why Facebook is now touching almost 2 billion people.

Q : You're in a unique position where you've written a book that informs companies how to hook users, but you also offer users advice about how to not let their habits and behaviors get out of control. Is that accurate, and if so, how do you balance those positions?

NE : The problem isn't that Facebook, Instagram, Slack, and these other companies know how to use these techniques. The problem is there are far too many companies that don't know how to use these techniques. Companies that could really benefit us. When you think of the state-of-the-art when it comes to interacting with local business or government services or starting healthy habits like eating better or keeping in touch with loved ones, so many products out there have the best intentions, but they just suck. They're not designed well. People don't use the product because they don't have these hooks embedded. That's why I wrote this book. I wrote this book for the designers out there, the engineers, the entrepreneurs who want to help people build healthy habits but for lack of good design, their products aren't changing behavior. That's the first reason I wrote the book.

The second reason I wrote the book is that the only way we can control these bad habits, or control how we use technologies, is to understand how they hook us—understand fundamentally what's behind our behavior. So it's very intentional that I'm just as much an advocate for building healthy habits in our lives as I am for breaking unhealthy habits that we don't want. But the source or root for doing either of those things—

building healthy habits or breaking unhealthy habits—is to understand how these habits work in the first place. And that's what the Hook Model is for.

Q : You're an advocate of using "attention-retention tools," or technologies that curb the triggers products use to hook users. What are some examples of attention-retention tools and how they benefit users?

NE : This is a natural progression of what technologies do. We have a technology. We adopt it wholesale. We think it's awesome, and then a little while later, we say, "Wait a minute, there are actually a lot of bad sides, too." If you think of the miracle of personal transport, a little more than a hundred years ago society had access to cars, and they changed the world. Of course, they also create pollution and accidents and all sorts of bad things come from this cool technology. So what do we do? Well, we build new technologies to fix the problems of the last generation.

There are tons of tools available today that individuals who care enough to do something about this problem can use to protect their attentional faculties, and the way they do that is by using these tools I call attention-retention devices. One example: In my house during the weeknights, I have a timer connected to my router. Every night at 10 p.m., my internet shuts off. I could clearly unplug my router from the timer and get back online, but it gives me that moment to think. That moment of mindfulness so that I don't keep surfing the web and can stop and ask myself, "Is this really important? Do I really need to be doing this now, or is sleep more important to me?"

I think those people who can master their attention, master their focus, this is going to be the competitive edge of the foreseeable future. It's not so much access to information. We're drowning in information. The rare commodity that differentiates who can do really great work in the years to come is going to be who can master their attention. I think these attention-retention tools will be a big part of that. ■

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06.02-04.17

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www.catacombz.com

06.10.17

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06.10-11.17

KCGameOn 75

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kcgameon.com

06.17.17

Oklahoma Gamers Group

Oklahoma City, OK

www.okgg.org

06.17.17

Source Gaming Lounge

Denton, TX

www.sourcegaming.org

06.24.17

eDrenaline eSports

Ashland, OH

www.facebook.com/groups/UGGeSports

06.24.17

River Valley LAN

Russellville, AR

www.rivervalleylan.com

06.25.17

FortLAN XI

Fort Wayne, IN

www.facebook.com/fortlan.org

07.15.17

Oklahoma Gamers Group

Oklahoma City, OK

www.okgg.org

07.15-16.17

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www.elayin.com

07.15.17

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www.sourcegaming.org

07.21-23.17

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Atlanta, GA

atlanta.dreamhack.com/17

07.21-24.17

PDXLAN 30*

Portland, OR

www.pdxlan.net

07.28-30.17

BAKOLAN

Bakersfield, CA

www.facebook.com/groups/Bakolan

07.29.17

eDrenaline eSports

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08.04-05.17

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coglan.org

08.19-20.17

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Ashland, OH
www.edrenaline.net

08.19.17

Oklahoma Gamers Group
Oklahoma City, OK
www.okgg.org

08.19.17

Source Gaming Lounge
Denton, TX
www.sourcegaming.org

08.24-27.17

QuakeCon
Dallas, TX
www.quakecon.org

08.25-27.17

AWOL LAN 30
Eau Claire, WI
www.awollan.com

09.01-04.17

PAX West*
Seattle, WA
west.paxsite.com

09.15.17

Oklahoma Gamers Group
Oklahoma City, OK
www.okgg.org

09.15.17

Source Gaming Lounge
Denton, TX
www.sourcegaming.org

09.16-17.17

LanOC v2.0
Van Wert, OH
lanoc.org/lan-parties

09.22-24.17

PONG EXPO LAN
Menomonie, WI
pong.uwstout.edu

09.30.17

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Ashland, OH
www.facebook.com/groups/UGGeSports

10.07.17

KCGameOn 77
Kansas City, MO
kcgameon.com

10.07-08.17

River Valley LAN
Russellville, AR
www.elayin.com

10.20-22.17

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denver.dreamhack.com/17

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Q&A With ENERMAX's Ko-Min Kevin Tseng, Ph.D.

Global Head Of Sales & Marketing

On The Company's 27th Birthday

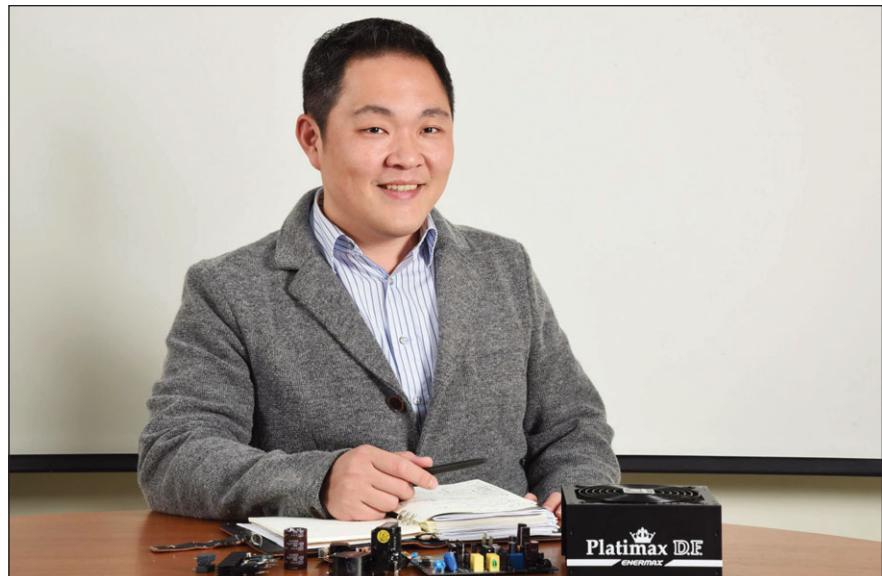
Q : First off, congratulations on your company reaching 27 years in the computer hardware industry! What was ENERMAX's first product, way back in 1990, and how did the company start?

KT : As some of you may know, we started as a power supply manufacturer. The first product we launched 27 years ago was the AT switching power supply with 200W. Unlike the present power supply units with premium coating or decent silk-print on the housing, PSUs were bare metal and quite unappealing back then. At the time, lots of people considered a power supply one of the least important components in the system. However, Steven Su, the founder and CEO of our company, and his business partners anticipated that if the IT industry kept developing, there would be a need for stable and reliable PC power supplies for advanced systems.

Prior to the establishment of the company, our founders served in executive positions in the IT industry. They have been well acquainted with the demands of ambitious PC hardware enthusiasts as customers and took the opportunity offered by the lack of quality, high-performance, and durable PC components at that time. Within a very short period of time, the ENERMAX brand became more and more popular around the world.

Q : How long have ENERMAX and LEPA been associated, and how did their association begin?

KT : ENERMAX is a world-renowned PC power supply unit manufacturer and designer, and our PSUs have been recommended by worldwide reviewers. Some



of them have been granted significant awards such as the 2009 Red Dot design award, the 2010 iF product design award (for the Revolution85+ power supply), the 2015 Computex d&i award, and the 2017 German Design Award for our Digifanless PSU.

ENERMAX is also an ODM (original design manufacturer) PSU provider. Back in 2010 when LEPA was established, it launched a PSU that was an ODM model by ENERMAX that quickly received the Dream Machine Award 2013 from *Maximum PC* magazine; that PSU is the G1600, which has 80 PLUS Gold certification and is the only 18cm-deep chassis that performs at 1,600W.

Q : How are ENERMAX and LEPA products different? Does each brand have a particular specialty or strength?

KT : ENERMAX is a sophisticated PSU designer and maker of peripherals

such as chassis, coolers, and fans; LEPA is a rising star creating fun and innovative computer DIY and consumer electronics products. ENERMAX focuses on developing advanced technology to bring consumers more convenient and efficient products. Take the REVOLUTION DUO PSU, for example: The dual-fan design is perfect for computer chassis with PSU shrouds and the patented FMA (Fan-speed Manual Adjustment) technology allows users to increase the system airflow manually.

LEPA always wants to offer entertaining and state-of-the-art products. For example, the NEOllusion CPU cooler provides 15 colors and various lighting effects that builders can use to customize their builds, and the Q-Boom Bluetooth speaker with selfie remote shutter function makes it easy to snap photos on your devices.

Q : How would you say the computer hardware market has changed the

most since ENERMAX began making computer components?

KT: Over two decades, PC DIY users have gained more experience in building their own PCs. More online resources, such as tech review sites, are available, which has helped enhance users' knowledge in selecting suitable PC components.

In addition to functionality and stability, nowadays product appearance has played a more important role in PC DIY. Lots of PC DIYers look for components with unique design to express their own personality and style. That's why we are seeing more and more PC chassis featuring ample, panoramic glass panels to allow users to showcase their rigs.

Q : On the other hand, what has been the biggest change in ENERMAX during that same time span?

KT: In 2011, we entered a brand-new product category—CPU coolers. With the same focus on innovation and reliability that has created numerous award-winning products, we launched our first CPU air cooler, the ETS-T40 series. The thermal resistance value reached an unmatched 0.09°C/W; the outstanding performance was based on the integration of several innovative cooling technologies: VGF (Vortex Generator Flow), VEF (Vacuum Effect Flow), and SEF (Stack Effect Flow). In 2012, we launched our first AIO CPU liquid coolers, the ELC series, which came with a 120mm or 240mm radiator. Thanks to the patented Shunt Channel cold plate technology, the ELC series achieved a better flow rate and ensured great heat dissipation, which made the liquid cooler an excellent choice for overclocking. In 2015, ENERMAX won the European Hardware Award for the LIQMAX II 240 AIO CPU water cooler.

Over the past six years, our innovations and patented cooling technologies have continuously defined new standards for the market. Power supplies have been and will still be our core business, but I would say CPU coolers will become more and more important in our business.

Q : As CPUs and GPUs become more efficient, PSUs have followed suit, and there seem to be a lot of enthusiast-grade sub-1,000W PSUs today. Do you expect that trend to continue?

KT: Yes, we expect so. We provide PSUs in the wattage range from 300W to 1,700W to meet different application needs. Kilowatt PSUs occupy a very niche segment. ENERMAX PSUs, especially 1,200W to 1,600W units, are frequently adopted to power professional workstations for fluid dynamics, medical research, financial modeling, real-time graphics, 3D rendering, and heavy-duty ray tracing applications. So we believe there will be continuing demand for kilowatt power solutions.

On the other hand, some users don't really know how much wattage they may need. That's why ENERMAX offers a Power Supply Calculator at www.enermax.outervision.com to help them get an estimate on how much wattage they may need, and to help users select a suitable PSU for their systems.

Q : ENERMAX has power supplies with lots of interesting innovations built into them, including dual-fan units, D.F.R. (Dust Free Rotation) technology, fanless PSUs, and so on. Can you give us any hints as to what the next big thing will be in the power supply market?

KT: Much like our hearts pump oxygenated blood to the rest of our bodies, a PC's PSU converts alternating current (AC) into direct current (DC) and delivers the DC to the rest of the computer, including the CPU, motherboard, RAM, SSD/HDD, and so on. So I believe most people would agree that a strong, stable, highly efficient power supply is the heart of a strong, stable, and highly efficient PC.

In the near future, therefore, we expect to see more high-efficiency PSUs available in the market, such as 80 PLUS Titanium-rated PSUs (currently the highest efficiency level) and 80 PLUS Platinum-rated units. We will be launching our new Titanium

and Platinum-rated lineups in early Q3 this year.

Furthermore, dimensions matter! Current high-efficiency 1,000W-plus PSUs on the market are generally large, many measuring 18cm to 22.5cm in depth. The larger dimensions necessitate a PC case with a lot of interior space, and this decreases a builder's freedom in selecting a chassis. To respond to the voice of the market, we'll be releasing a fully modular, Platinum-rated 1,200W PSU with a depth of only 16cm to give enthusiasts greater flexibility in case selection.

Last but not least, user-friendly designs are always what builders look for. After the launch of the D.F.R. technology, which makes the fan spin in reverse for 10 seconds upon startup to blow away the dust and prevent buildup, we have received feedback from our customers who wanted an option to activate D.F.R. at any time during the unit's operation. Users told us that they seldom turn off their computers, and since the current D.F.R. function is only activated at startup, they couldn't fully enjoy its benefits. Consequently, we've created the D.F. switch for users to activate the D.F.R. at any time during the PSU's operation. The D.F. switch is placed near the PSU's on/off switch, and the switch will be implemented in our new Titanium and Platinum PSU lines.

Q : We noticed on your site that ENERMAX is giving away some prizes as part of the birthday celebration in conjunction with Amazon and Newegg. Can you talk about what readers need to do to be eligible for the giveaways?

KT: Yes of course! It's actually pretty simple! From now until May 31, all you have to do is leave a review on Amazon or Newegg of your recent ENERMAX or LEPA purchase during this year, and you can not only get a free ENERMAX sporty earphone (MSRP \$19.99) but also a chance to win grand prizes, including power supplies, cases, coolers, graphics cards, memory, and more thanks to our friends at PNY and ADATA! You can visit the event site at www.enermaxusa.com/enermax27. ■



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